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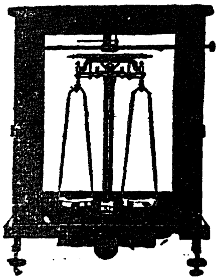

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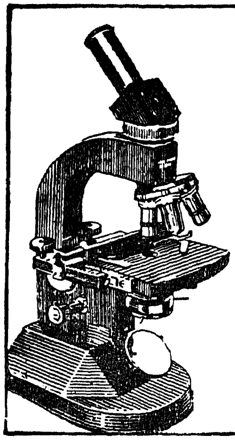

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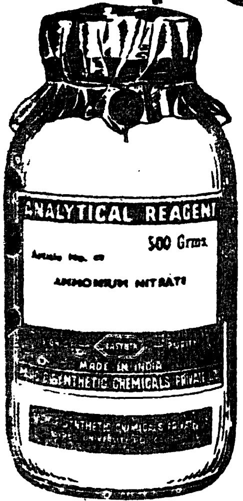

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STUDY OF REVERSION IN ALUMINIUM-ZINC ALLOYS CONTAINING 20 AND 30 AT.% ZINC

R. P. WAHI AND T. R. ANANTHARAMAN

Department of Metallurgy, Institute of Technology, Banaras Hindu University, Varanasi-5

ABSTRACT

A metastable miscibility gap for G.P. zones in aluminium-zinc alloys has been established on the basis of hardness reversion studies. X-ray examination of the sequence of precipitation in these alloys has revealed the presence of a zinc-rich rhombohedral intermediate phase on ageing the alloys in the range of 200–310° C. A second high-temperature metastable miscibility loop is postulated to explain the experimental observations satisfactorily.

INTRODUCTION

MANY attempts have been made in recent years to establish the metastable equilibrium between Guinier-Preston Zones (to be referred to as zones hereafter) and their matrix in Al-Zn alloys. The results of Borelius,[1] Johnson *et al.*[2] and very recently Strongin[3] indicate that the metastable phase boundary lies well below the monotectoid temperature (275° C.). On the other hand, the work of Carpenter and Garwood,[4] Larsson[5] and Lasek[6] suggests that the boundary is obtained almost by extrapolation of the high temperature α–α' miscibility gap (Fig. 1) to lower temperatures.

The present investigations which form part of a detailed study of the precipitation phenomena in Al-Zn alloys were undertaken by us to determine the above-referred metastable phase boundary independently through a study of hardness reversion. This technique was originally employed by Beton and Rollason[7] to determine G.P. zone solvus in Al-Cu alloys. The X-ray and optical metallographic techniques were also employed, wherever possible, to support the findings. Since the controversy over the position of the boundary is mainly in the composition range of concentrated alloys, we shall discuss here primarily the results on alloys containing 20 and 30 at.% Zn, although our studies were extended to alloys containing 5 and 10 at.% Zn.

EXPERIMENTAL PROCEDURE

The alloys were prepared from super-purity aluminium (99·999 + %) and high-purity B.D.H. zinc (99·99 + %). Weighed quantities of aluminium were melted in graphite crucibles heated in an electric muffle furnace. Required amounts of zinc wrapped in aluminium foil were added to liquid aluminium and the molten alloy homogenised for 15 minutes before pouring into cylindrical graphite moulds of 2 cm. inside diameter and 10 cm. length. The ingots were hot-forged to 0·5 cm. thick plates which were then homogenised and stress-relieved at 350° C. for 4 days. Samples (2 × 1 × 0·5 cm.) cut from these sheets were employed for hardness measurements. For X-ray diffraction studies wires of 0·25 mm. diameter were drawn from thin strips cut from the forged sheets. A careful chemical analysis showed the alloys to be within ± 0·2 at.% of the desired composition. The grain size of the alloys prior to the reversion studies was in the range of 90–120 microns.

A common treatment of quenching from 400° C. in water and ageing at room temperature (30° C.) for 30 minutes was given to every alloy specimen before studying hardness reversion at various temperatures upto the monotectoid temperature. This was done, on the basis of preliminary ageing studies, to enable the alloys to attain a constant hardness at room temperature before starting the reversion treatment. After each reversion treatment the samples were quenched in water and the change in hardness at room temperature followed for some time. The extrapolated value of hardness corresponding to zero ageing time at room temperature was used for plotting the reversion curves. All the hardness measurements were made on a Vickers-Armstrong Hardness Testing Machine using a 5 kg. load.

Wire samples for X-ray diffraction studies were directly quenched to and aged at different temperatures, as well as water-quenched and then aged at respective elevated temperatures. An 11·4 cm. dia. Debye-Scherrer camera and nickel-filtered Cu K_α radiation were employed for getting the diffraction patterns. All the samples were given an exposure of 1½ hours at 35 kV and 15 mA.

The optical metallographic studies were conducted on the same samples as used for the hardness reversion studies. All the samples were electropolished and examined under a Leitz Panphot Metallograph.

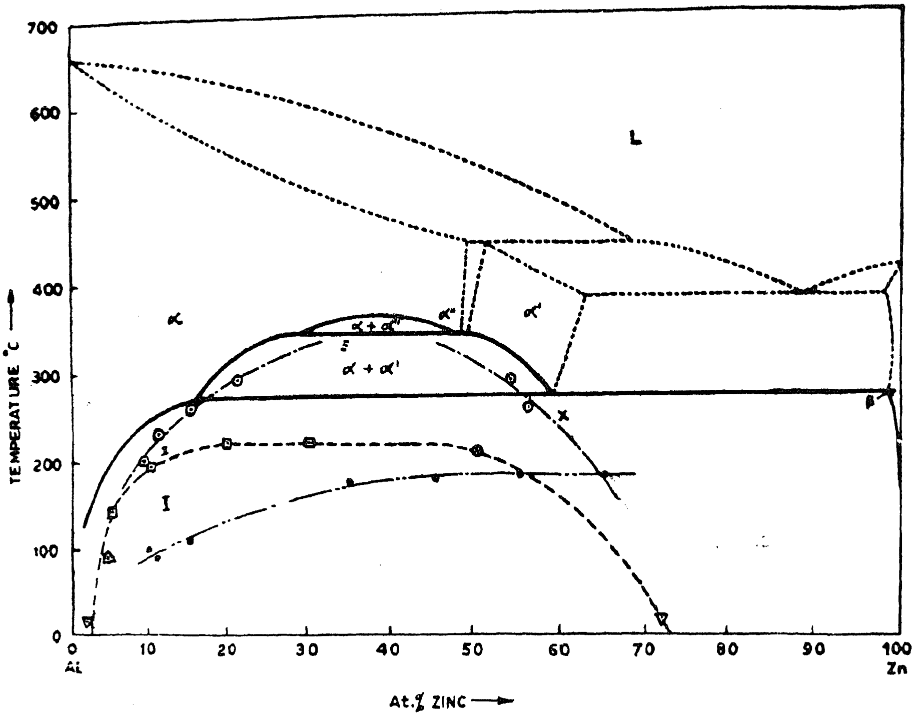

FIG. 1. Al-Zn equilibrium diagram (according to Goldak and Parr[18]) showing the proposed metastable miscibility loops for G.P. zones (— — —) and the rhombohedral transition phase (•—•—•—). ☐ Present hardness reversion studies, ⊙ present X-ray studies, ● Borelius[1], ⊗ Johnson *et al.*,[2] I Strongin[3], ▽ Gerold and Schweizer[8], △ Panseri and Federighi,[9] × Simerska and Synecek.[13]

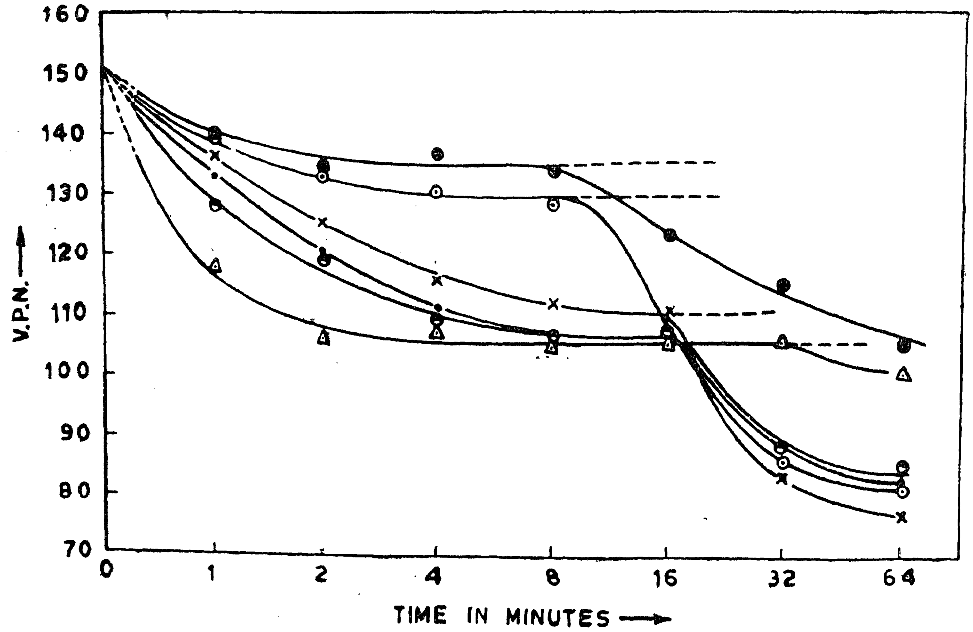

FIG. 2. Reversion curves obtained from an Al-20 at.% Zn alloy at 170° (●), 200° (⊙), 210° (×), 220° (•), 230° (⊖) and 260° C. (△).

EXPERIMENTAL RESULTS AND DISCUSSION

Figure 2 shows the reversion curves obtained for the 20 at.% Zn alloy at 170°, 200°, 210°, 220°, 230° and 260° C. Similar curves were obtained for the 30 at.% Zn alloy also. For both compositions, the hardness falls at a given reversion temperature in two different stages and at two different rates. An initial fast rate of fall which decreases with time (Stage 1) is generally followed by a relatively slower rate of fall (Stage 2). The former is obviously caused by the dissolution of zones formed at room temperature, while the latter is due, on the evidence of X-ray data, to heavy precipitation of the equilibrium zinc phase. Towards the end of Stage 1 the two processes seem to overlap. The value of hardness at the end of Stage 1 remains the same for reversion temperatures above 220° C. for both the alloys. This temperature is, therefore, taken to represent the upper limit of zone stability in both the alloys. Figure 1 shows the metastable miscibility loop on the basis of present investigations as well as those on 5 and 10 at.% Zn alloys (not described here) and also the work of some earlier investigators.[1-3,8,9] The following additional information was obtained from X-ray and optical metallographic studies on structural changes in these alloys during and after reversion at various temperatures between room temperature and the monotectoid temperature.

(1) Discontinuous precipitation of zinc at grain boundaries was found to be the major mode of decomposition in both alloys at and below 170° C. Sequential transformation of the zones to equilibrium zinc through intermediate phases, as reported by earlier investigators,[10,12-14] was found to be absent or negligible in this temperature range.

(2) On reversion at 200° C. and above, a zinc-rich rhombohedral transition phase was detected at time intervals roughly corresponding to Stage 1. This phase could be indentified as the 'R' phase reported by earlier investigators.[10-14] It is relevant to note here that a considerable fall in hardness was always recorded at all temperatures in the 200–275° C. range before this transition phase made its appearance.

(3) The rhombohedral transition phase was found to form also on ageing the alloys directly quenched to temperatures in the range of 200-310° C. Zinc concentrations in the matrix and the transition phase, obtained on direct quenching, were calculated using Ellwood's data for lattice parameters of Al-Zn alloys.[15] When plotted on the Al-Zn equilibrium diagram, these values seem to give rise to a second metastable miscibility loop (Fig. 1) extending well into the high temperature α–α' miscibility gap.

(4) At time intervals corresponding to Stage 2 it was observed that the transition phase disappeared completely and heavy precipitation of zinc followed. In the alloy richer in zinc, such precipitation started much earlier and overlapped appreciably on the other two processes in Stage 1, *viz.*, dissolution of zones and formation of the transition phase.

Considered along with the hardness data, the above results strongly suggest the existence of two metastable miscibility loops in the Al-Zn system as shown in Fig. 1. The first extending from lower temperatures to about 220° C., represents the metastable equilibrium between zones and the matrix and is in good agreement with the results of Johnson,[2] Gerold and Schweizer[8] and Panseri and Federighi.[9] It is also in qualitative accord with the data of Borelius[1] and Strongin,[3] although lying at temperatures appreciably higher than those suggested by their results. The second, extending into the high temperature α–α' miscibility loop and in partial agreement with the conclusions of Carpenter and Garwood,[4] Larsson,[5] Lasek,[6] Cahn[16] and Rundman and Hilliard,[17] represents the metastable equilibrium between the rhombohedral transition phase and the matrix. The two loops overlap around 170–220° C. contributing to the observed greater complexity of the precipitation process in this temperature range, as also its sensitivity to the thermal history of the samples under investigation.

We believe that it is possible to explain all our observations and most of those of earlier investigators on reversion in Al-Zn alloys more satisfactorily than hitherto on the basis of the above-mentioned two metastable miscibility loops. It is worth recording in this connection that the investigations of Strongin[3] on an Al-12 at.% Zn alloy have also shown the existence of two different metastable phases. One, identified as a transition phase, has been shown to form around 210–215° C., while the other, identified as zones, exists upto around 146–157° C. These temperatures are slightly lower than those obtained in the present investigations, but definitely suggest the existence of two metastable miscibility loops.

On re-heating alloys, quenched to room temperature and aged at that temperature to produce zones, to temperatures in the range of 170–220° C., some of the zones get dissolved in accordance with the low-temperature miscibility loop. The remaining zones grow further and are able to nucleate the transition phase in accordance with the high-temperature miscibility loop. The expected shift in equilibrium also occurs on reverting the alloys at temperatures above the lower miscibility loop, *i.e.*, at temperatures above 220° C. However, the question still remains open whether at these high temperatures dissolution of *all* the zones takes place or the larger zones transform to the rhombohedral phase. Further, there is no certainty about the mode of precipitation of zinc in these concentrated alloys on reversion above 170° C. It may form sequentially as suggested by some earlier investigators[10,12–14] and/or by discontinuous and continuous precipitation at grain boundaries and lattice defects.

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RADIOCARBON DATES OF SOME CHALCOLITHIC SAMPLES

D. P. AGRAWAL AND SHEELA KUSUMGAR
Tata Institute of Fundamental Research, Colaba, Bombay–5

ABSTRACT

Radiocarbon dates, given here, were measured by counting methane in gas proportional counters. The C^{14} dates place the beginning of the Black-and-red Ware of Chirand (Bihar) to 8th-9th century B.C., the West Bengal Black-and-red Ware being still earlier. Kayatha Culture has been dated to *ca.* 1900 B.C.

RADIOCARBON dates of some samples from the excavated Chalcolithic sites of Chirand, Eran, Mahisdal, Kayatha and Sonegaon, are presented in this report.

The samples were given the usual pretreatment, wherever possible, for the removal of extraneous carbonates and humic acid. Visible rootlets were picked manually. The samples were counted in the form of methane in gas proportional counters. For modern reference standard 95% activity of the N.B.S. oxalic acid was used. Detailed procedures have been described by us in earlier papers (Kusumgar *et al.*, 1963; Agrawal *et al.*, 1965).

All dates given below are in years B.P. To convert them to A.D./B.C. scale, 1950 should be used as the reference year. Each sample has two dates: the first one is based on the half-life value of 5568 ± 30 yrs.; the second date, given within brackets, on 5730 ± 40 yrs. For all intercomparison dates based on the same half-life value should be used.

GENERAL COMMENT ON DATES*

From Chirand, the date TF-444, 2665 ± 105, presented here, is in the series of TF-331, 2795 ± 125 and TF-336, 2715 ± 100 (Agrawal *et al.*, 1966)—all internally consistent within one standard deviation. These dates place the beginning of Black-and-red ware in Chirand to 8th-9th century B.C. The Black-and-red ware of Bengal antedates that of Bihar, as indicated by Mahisdal dates TF-390, –391 and –392, given below. TF-445 from Chirand is a wood sample from a natural pit from which a large number of microliths, unassociated with any ware, were reported and hence this date should not be used to date the Black-and-red ware of Chirand.

The C^{14} dates from the earlier excavations from Kayatha had shown some scatter. Therefore more samples were collected under more controlled conditions in the subsequent excavations conducted by the Deccan College, Poona. These show a fair internal consistency and place the beginning of the Kayatha Culture to *ca.* 1900 B.C.

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* For discussions the dates based on the half-life value of 5730 yrs. have been used.

C^{14} DATES WITH SAMPLE DESCRIPTIONS

Chirand, Bihar, India

Chirand (Lat. 25° 45′ N., Long. 84° 45′ E.), District Saran, is a protohistoric site being excavated by Dr. B. S. Verma. The samples were submitted by the Director of Archæology, Patna.

TF-445, Natural Pit
3500 ± 100 (3600 ± 100)

Wood from Trench CRD-X, Locus A 2, pit sealed by layer 11, Depth 8·2 m. NaOH pretreatment was also given. Comment: The sample is from a pit in natural soil which yields large number of microliths which is sealed by Black-and-red Ware deposits.

TF-444, Black-and-red Ware Deposits.
2590 ± 105 (2665 ± 105)

Charred wood from Trench CRD-VII, Locus A 2, Layer 16, Depth 10·5 m. NaOH pretreatment was also given.

Eran, Madhya Pradesh, India

Eran (Lat. 24° 5′ 16″ N., Long 78° 10′ 24″ E.), District Sagar, was excavated by Prof. K. D. Bajpai, Department of Archæology, University of Sagar, who submitted the samples.

TF-330, Period I, 3220 ± 100
(3315 ± 100)

Charcoal from ERN 7, Locus IV′-IX′, Layer 20, Depth 7·7 m. Sample No. ERN 7/C/6263/7.

TF-327, Period I, 3280 ± 100
(3375 ± 105)

Charcoal from ERN 7, Locus VI′-IX′, Layer 17, Depth 6·8 m. Sample No. ERN 7/C/62-63/4.

TF-329, Period I, 3300 ± 105
(3395 ± 110)

Charcoal from ERN 7, Locus VI′-IX′, Layer 19, Depth 7·5 m., Sample No. ERN 7/C/62-63/6.

TF-331, Period I, 3355 ± 90
(3450 ± 95)

Charcoal from ERN 7, Locus IV′-IX′, Layer 21, Depth 8·0 m., Sample No. ERN 7/C/62-63/8.

Mahisdal, West Bengal, India

Mahisdal (Lat. 23° 42′ 45″ N., Long. 87° 41′ 33″ E.), District Birbhum, was excavated by Shri R. P. Das and the samples were submitted by the Director-General of Archæological Survey of India, New Delhi-11.

TF-390, Chalcolithic Culture, 2725 ± 100
(2805 ± 100)

Charred rice from Trench MDL-1, Locus I-II, Layer 4, Depth 1·45 m., Field No. MDL-1/C/64-2. NaOH pretreatment was also given. Comment: From late phase.

TF-392, Chalcolithic Culture, 2950 ± 105
(3035 ± 110)

Charcoal from Trench MDL-1, Locus IV-VI, Layer 5, Depth 1·30 m., Field No. MDL-1/C/64-4. Visible rootlets were removed. NaOH pretreatment was also given.

TF-391, Chalcolithic Culture, 3235 ± 105
(3330 ± 105)

Charcoal from Trench MDL-1, Locus VII-VIII, Pit 3 sealed by Layer 5, Depth 1·61 m., Field No. MDL-1/C/64-3.

Kayatha, Madhya Pradesh, India

Kayatha (Lat. 23° 30′ N., Long. 76° E.), District Ujjain, the site was excavated by Dr. H. D. Sankalia, Deccan College, Poona-6, who submitted the samples. The samples marked with an asterisk have been submitted by Shri V. S. Wakankar, Vikram University, Ujjain, who had excavated the site earlier.

TF-776, Chalcolithic Culture, 3455 ± 110
(3555 ± 115)

Charcoal from Trench A, Layer 4, Depth not given, Field No. 111. NaOH pretreatment was also given.

TF-777, Chalcolithic Culture, 3625 ± 95
(3730 ± 100)

Charcoal from Trench A, Layer 5, depth not given, Field No. 361. NaOH pretreatment was also given.

TF-778, Chalcolithic Culture, 3550 ± 95
(3655 ± 95)

Charcoal from Trench A, Layer 6, Depth not given, Field No. 599. NaOH pretreatment was also given.

TF-779, Chalcolithic Culture, 3685 ± 105
(3790 ± 110)

Charcoal from Trench A, Layer 7, Depth not given, Field No. 693.

TF-780, Chalcolithic Culture, 3680 ± 95
(3785 ± 100)

Charcoal from Trench A, Layer 8, Depth not given, Field No. 697.

TF-781, Chalcolithic Culture, 3720 ± 105
(3830 ± 105)

Charcoal from Trench A, Layer 9, Depth not given, Field No. 976. NaOH pretreatment was also given.

TF-396, Chalcolithic Culture, 3575 ± 105*
(3680 ± 110)

Charcoal from KTH-1, Layer 32, Depth 7·80 m., Field No. 5, NaOH pretreatment was also given.

TF-397, Chalcolithic Culture, 3350 ± 100*
(3450 ± 100)

Charcoal from KTH-1, Layer 33, Depth 8 m., Field No. 7. NaOH pretreatment was also given.

TF-399, Chalcolithic Culture, 3525 ± 100*
(3625 ± 100)

Charcoal from KTH-1, Layer 37, Depth 9·1 m., Field No. 8. NaOH pretreatment was also given.

TF-400, Chalcolithic Culture, 3800 ± 105*
(3915 ± 110)

Charcoal from KTH-1, Layer 38, Depth 9·60 m., Field No. 9. NaOH pretreatment was also given.

TF-401, Chalcolithic Culture, 3190 ± 105*
(3285 ± 105)

Charcoal from KTH-1, Layer 39, Depth 10 m., Field No. 10. NaOH pretreatment was also given. Comment: Date is younger than expected.

TF-402, Chalcolithic Culture, 3240 ± 100*
(3330 ± 100)

Charred wheat from KTH-1, Layer 35, Depth not given, Field No. 11. NaOH pretreatment was also given. Comment: Date is younger than expected.

TF-405, Chalcolithic Culture, 3320 ± 100*
(3415 ± 100)

Charcoal from KTH-2, Layer 10, Depth 3·5 m., Field No. 14. NaOH pretreatment was also given.

TF-680, Chalcolithic Culture, 3850 ± 95*
(3965 ± 100)

Charcoal from Trench KTH-3, Layer 13, Depth not given, Field No. 21.

TF-678, Chalcolithic Culture, 3530 ± 100*
(3635 ± 100)

Charcoal from Trench KTH-4, Layer 18, Depth not given, Field No. 19.

TF-676, Chalcolithic Culture, 3160 ± 105*
(3255 ± 105)

Burnt wheat grains from Trench KTH-4, Layer 14, Depth not given, Field No. 17. NaOH pretreatment was also given.

TF-679, Chalcolithic Culture, 3155 ± 1*
(3250 ± 135)

Charcoal from Trench KTH-3, Layer
Depth not given, Field No. 20.

Sonegaon, Maharashtra, India

Sonegaon (Lat. 18° 39′ N., Long. 74° 5′
District Poona, the site is being excavated
Dr. H. D. Sankalia, who submitted the sam
The site is culturally akin to Jorwe
Nevasa.

TF-379, Jorwe Culture, 3150 ± 90
(3240 ± 95)

Charred grain from Mound II, Layer
Depth 1·2 m., Field No. 69. Visible roo
removed.

TF-383, Jorwe Culture, 3185 ± 100
(3280 ± 100)

Charcoal from corner of baulk-cutt
Field No. 303. NaOH pretreatment was
given.

TF-380, Jorwe Culture, 3230 ± 105
(3325 ± 110)

Charcoal from Mound II, Layer 4, De
1·8 m., Field No. 120. Visible rootlets remo
NaOH pretreatment was given.

TF-382, Jorwe Culture, 3195 ± 100
(3290 ± 100)

Charred wheat from Mound II, Layer
Depth 2·2 m., Field No. 136.

TF-384, Jorwe Culture, 3415 ± 105
(3515 ± 110)

Charcoal from Mound II, Layer 7, De
4·2 m., Field No. 321. Visible rootlets w
hand-picked. NaOH pretreatment was
given.

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MORPHOGENESIS OF EMBRYO IN A PARASITIC ANGIOSPERM *EXOCARPUS CUPRESSIFORMIS*

S. S. BHOJWANI

Department of Botany, University of Delhi, Delhi-7

Of late, the technique of *in vitro* culture has been profitably employed for studying seed germination and embryo morphogenesis in parasitic angiosperms. Unlike stem-parasites, root-parasites fail to germinate on sim
nutrient media.[1–3] In some species of rc
parasites, shoot morphogenesis has been dem
strated to be host-dependent.[4,5]

Exocarpus cupressiformis Labill. is an arborescent root-parasite (Santalaceae). Ripe fruits of the parasites were obtained from Australia through the courtesy of Professor Gwenda L. Davis. Seeds (Fig. 1, A) were excised from the fruits, washed with 1% cetri-

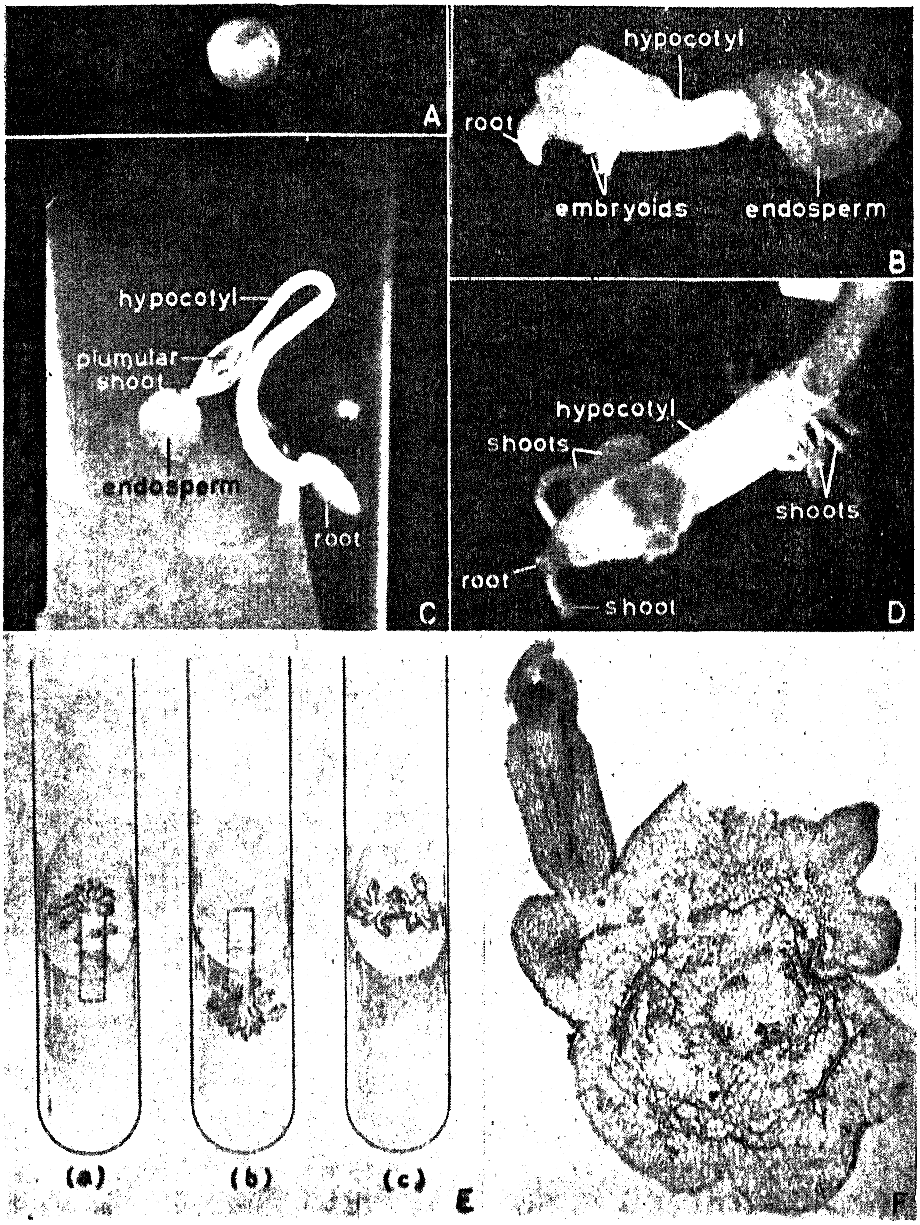

FIG. 1. A–F. A. Seed at culture, × 2·5 B. 15-week old culture on 400 ppm CH + 1 ppm IAA; the hypocotyl close to radicle has developed an arc of embryoids, of which only 2 are in view. × 9. C. Seedling formed in 15-week-old culture on WM + 400 ppm CH + 1 ppm IAA + 1 ppm Kn, plumule has developed into a small shoot, × 2·5. D. Root-hypocotyl part of axis of 15 week old seedling formed on medium as in C, × 5. E. Diagrammatic representation of polarity in differentiation of shoot-buds from hypocotyl segments; both in *a* (basal end embedded in the medium) and *b* (apical end embedded in the medium) shoot-buds developed from the morphological apical end, in *c* (explants lying horizontally on the medium) shoot buds developed along the free surface of the explant. F. Transection of a 6-week-old culture of hypocotyl segments on medium as in C; note exogenous origin of the shoot-bud, × 53.

mide solution (trade name 'Cetavlon', ICI), surface sterilized with chlorine water for 10 min., thoroughly rinsed in sterile distilled water, and finally implanted under aseptic conditions on modified White's medium[6] without IAA (WM). In some experiments WM was supplemented with casein hydrolysate (CH, 400 ppm), kinetin (Kn, 1 ppm), and IAA (1 ppm), both individually and in various combinations. Each experiment was repeated twice with 24 cultures each. The cultures were maintained in diffuse daylight (5-20 ft-c) at 25 ± 2° C and 50–60% relative humidity.

In Santalaceæ, the endosperm is directly surrounded by the pericarp since the integuments as well as endocarp are consumed by the endosperm. Thus, the seeds are naked. The seeds implanted on WM remained quiescent indefinitely. On WM + 400 ppm CH + 1 ppm IAA, 23% of the explants put forth the radicle in 3-week-old cultures. Whereas the radicle occasionally formed a small root, the plumule failed to develop into a shoot. In one instance, 7 embryo-like structures (embryoids) appeared on the hypocotyl close to the root (Fig. 1, B). In 19% cultures, the radicular end proliferated upon coming in contact with the culture medium. Subsequently, both roots and shoots differentiated from the proliferated mass.

With the addition of 1 ppm Kn to WM + CH + IAA, the radicle formed a short root in 25% cultures. Of the 500 cultures raised on this medium, only 5 showed the development of plumule into a shoot (Fig. 1, C). However, it remained arrested within the cotyledons. Although plumule seldom formed a shoot, differentiation of shoot-buds from endosperm[7] and hypocotyl (Fig. 1, D) occurred in 10 and 35% cultures, respectively. Besides the buds on injured seedlings (reparative buds), the hypocotyl also developed additional buds (on intact seedling).

From seedlings with *ca* 7 cm long hypocotyl, 1 cm long segments of the latter were excised and implanted on WM + CH + IAA + Kn, to study their regeneration potentiality. These were placed (*a*) vertically with the basal end (toward the radicle) embedded in the agar medium; (*b*) vertically with the apical end (toward the plumule) embedded in the medium; and (*c*) horizontally on the medium (*see* Fig. 1, E).

In the first set shoot-buds developed from the free end of the segment (Fig. 1, E, *a*) whereas, in the second set buds appeared from the end embedded in the medium (Fig. 1, E, *b*). Thus, in both sets, shoot-buds developed from the morphological apical end in strictly polar fashion. Curiously, in the third set (horizontal position), buds developed all along the upper surface of the explants (Fig. 1, E, c), indicating that the polarity was disturbed. Similar disturbance in polarity has been reported in experiments with stem-cuttings of willow[8,9] and root-cuttings of cabbage.[10]

Buds originated exogenously as parenchymatous outgrowths in 10-day-old cultures of hypocotyl segments. In another 4 days, these buds produced leaf primordia. The shoot-buds showed well-differentiated vasculature which was unconnected from the stele of the parent explant (Fig. 1, F).

Thus, the seeds of *E. cupressiformis,* a root-parasite, can germinate on nutrient medium in the absence of the host or host-extract. Shoot-buds, from either plumule or hypocotyl, develop only on a medium containing kinetin.

I am indebted to Professor B. M. Johri for his keen interest in the work, to Dr. N. S. Rangaswamy for valuable suggestions, and to Professor Gwenda L. Davis for supplying fresh fruits of *E. cupressiformis*. Financially, the work was supported by the Ministry of Education, Government of India, by awarding a Research and Training Scholarship.

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* Not seen in original.

LETTERS TO THE EDITOR

ANISOTROPIC LATTICE THERMAL EXPANSION OF ANTIMONY

THIS paper reports values of the lattice parameters of antimony at different temperatures between 28° and 220° C. and also the temperature variation of the principal coefficients of its thermal expansion. Specpure metal, obtained from John-Mathey and Co., was annealed in vacuum for about six hours at 250° C., before being used in the high-temperature flat-plate powder camera. The experimental technique and the method of evaluating the results were the same as described earlier.[1,2] The reflections measured and used in the calculations were $(32\cdot4)\alpha_1$, $(41\cdot0)\alpha_1\alpha_2$, $(32\cdot5)\alpha_1$, $(41\cdot3)\alpha_2$ and $(20\cdot13)\alpha_1\alpha_2$. Table I gives the values of the parameters 'a' and 'c' of the hexagonal cell at different temperatures.

TABLE I

Values of the lattice parameters and the axial ratio of antimony at different temperatures

Temperature °C.	'a' Å	'c' Å	c/a
28	4·3079 ±0·0004*	11·2741 ± 0·002*	2·6170
59	4·3087	11·2792	2·6178
91	4·3101	11·2869	2·6187
116	4·3119	11·2954	2·6196
168	4·3135	11·3053	2·6209
175	4·3145	11·3053	2·6203
220	4·3161	11·3141	2·6216

* Standard errors calculated by the method of Jette and Foote.[3]

The principal coefficients of thermal expansion α_a and α_c at different temperatures were evaluated from the temperature-parameters graphs following the method suggested by Deshpande and Mudholker.[4] The results are shown in Fig. 1, in which earlier macroscopic data reported by Hidnert[5] (and others[6,7]) have also been plotted for comparison. It can be noted from Fig. 1 that while the temperature variation of α_a is qualitatively similar to each other in the two cases, that of α_c is not. According to Hidnert's data, the coefficient of expansion along the c-axis increases with temperature whereas it is found, in the present study, to decrease with increasing temperature. The mean coefficients of expansion derived from the present data over the range 30° to 200° C. are $\bar{\alpha}_a = 11\cdot3 \times 10^{-6}/°$ C. and $\alpha_c = 19\cdot3 \times 10^{-6}/°$ C. These values are in satisfactory agreement with those given by Fizeau[6] and Erfling[7] and more so with those derived from the lattice parameter temperature graphs given by Klemm *et al.*[8] Table II gives these values by way of comparison.

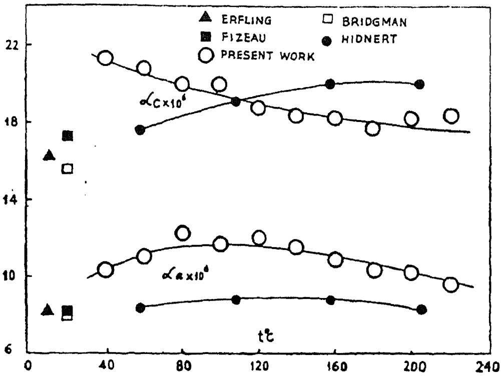

FIG. 1. Temperature variation of thermal expansion of Sb.

TABLE II

Comparison of the mean values of the coefficients of expansion of antimony

Author		Range of temperature ° C.	$\alpha_a \times 10^6/°$ C.	$\alpha_c \times 10^6/°$ C.
Fizeau[6]	..	0– 90	8·3	17·3
Erfling[7]	..	0– 90	8·2	16·2
Klemm *et al.*[8]	..	0–100	9·5	16·1
,,	..	0–200	9·5	17·1
Present study	..	30–100	11·3	19·4

Dept. of Physics,
Univ. College of Science,
Osmania University,
Hyderabad-7, *August* 25, 1968.

V. T. DESHPANDE.
RAM RAO PAWAR.

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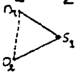
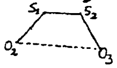
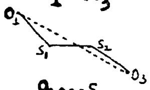
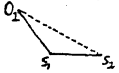
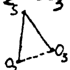
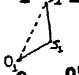
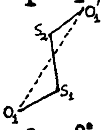
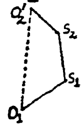
GENERALISED MEAN SQUARE AMPLITUDES OF VIBRATION OF SOME SULPHUR IONS

IN this paper, we report the generalised mean square amplitudes of vibration of some sulphur ions, namely SO_4, S_2O_3, S_2O_4 and S_2O_6. The sulphate ion belongs to T_d point group with $1a_1 + 1e + 2f_2$ type vibrations, whereas the structure of thiosulphate ion is similar to sulphate ion but with one of its oxygen atoms replaced by a sulphur ion, and belongs to the class C_{3v}. The six normal vibrations are categorised into $3a_1 + 3e$. S_2O_4 ion is planar with D_{2h} symmetry and the normal vibrations are classified as $3a_{1g} + 2b_{1g} + 2b_{2u} + 2b_{3u}$. The dithionate ion is staggered X_2Y_6 type

TABLE I

Generalised mean square amplitudes (Å²) of vibration of some sulphur ions

Molecule	Atom pair	$\langle(\Delta z)^2\rangle$	$\langle(\Delta x)^2\rangle$	$\langle(\Delta y)^2\rangle$	$\langle(\Delta z\,\Delta x)\rangle$	$\langle(\Delta z\,\Delta y)\rangle$	$\langle(\Delta x\,\Delta y)\rangle$
SO_4	S — O	0·001782	0·002345	0·002731	..	..	−0·000445
	O...O	0·004529	0·001699	0·001640	0·000188	−0·000605	−0·000743
S_2O_3	S — O	0·001843	0·001979	0·003270	0·001172	..	..
	S — S	0·001970	9·005730	0·005730	..	..	..
	O...O	0·004581	0·011843	0·003941	..	..	−0·001078
	S...O	0·008005	0·006448	0·006360	−0·002630	..	..
S_2O_4	S — O	0·001793	0·009041	0·005237	−0·005271	−0·003019	0·004318
	S — S	0·002001	..	0·007510	..	..	.
	$O_1 \ldots O_2$ 	0·014190	0·017[illegible]01	0·007446	..	..	..
	$O_2 \ldots O_3$ 	0·008445	..	0·004046	..	..	..
	$O_1 \ldots O_3$ 	0·011620	0·004523	0·004479	0·006596	0·004402	0·003155
	$O_1 \ldots S_2$ 	0·008058	0·002356	0·006151	0·005249	0·003366	0·001488
S_2O_6	S — O	0·001697	0·004766	0·001059	−0·002288	−0·000[illegible]26	0·000455
	S — S	0·001991	0·002175	0·002175	..	..	0·000560
	$O_2 \ldots O_3$ 	0·008590	0·001415	0·010764	0·000365	0·002031	0·001222
	$O_1 \ldots S_2$ 	0·002271	0·004559	0·001061	−0·001987	−0·001278	0·000435
	$O_1 \ldots O_1'$ 	0·011820	0·004287	0·001610	−0·000981	−0·000516	0·000322
	$O_1 \ldots O_2'$ 	0·008437	0·001764	0·002978	−0·000498	−0·001554	−0·000198

belonging to D_{3d} point group with $3a_{1g} + 1a_{1u} + 2a_{2u} + 3e_g + 3e_u$ vibrations. Expressions are derived for the generalised mean square amplitudes of vibration employing the method of Morino and Hirota[1] and the calculated values are listed in Table I. Since electron diffraction values are not available for these ions, no comparison could be made for the mean square amplitudes reported here.

Department of Physics, K. VENKATESWARLU.
Kerala University, MISS V. MALATHY DEVI.
Alwaye-4, *August* 7, 1968.

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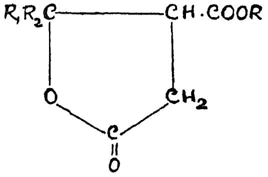
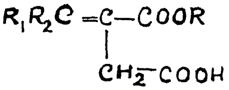
ALKOXIDE CLEAVAGE OF PARACONIC ESTERS

IT is observed that paraconic esters (I *a* and I *c*) undergo extremely facile ring cleavage with potassium tert.-butoxide in the cold to yield the unsaturated acids (II *a* and II c); while surprisingly with sodium ethoxide under identical conditions, there is no cleavage and the paraconic esters are recovered.



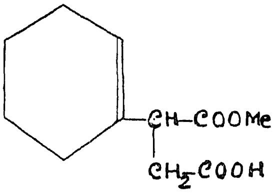
I



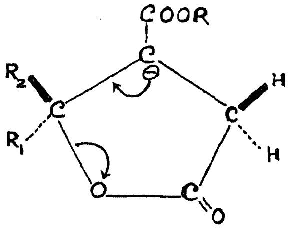
$R_1R_2C{=}C(COOR)CH_2{-}COOH$

II

a : R_1R_2 = Cyclohexyl, R = Me
b : R_1R_2 = Cyclohexyl, R = H
c : $R_1 = C_6H_5$, R_2 = H, R = Me
d : $R_1 = C_6H_5$, R_2 = H, R = H



III



IV

Methyl γ, γ-pentamethyleneparaconate[1] (I *a*) on treatment with potassium tert.-butoxide in tert.-butanol at 0-20° for 15 min. gave β-methoxycarbonyl-β-cyclohexylidene propionic acid (II *a*). This, on refluxing with potassium tert.-butoxide in dry tert.-butanol rearranged to the cyclohexenyl ester (III) having the endocyclic double bond.[2] Alkaline hydrolysis of the half-ester (II *a*) gave cyclohexylidene succinic acid (II *b*), and of the paraconic ester (I *a*) gave the corresponding acid (I *b*). With either of the alcoholic alkoxides under refluxing conditions, the paraconate (I *a*) yielded cyclohexenyl succinic acid (III).[1,3,4]

Similar results were obtained from phenylparaconic ester (I c) which was prepared by esterification of the paraconic acid (I *d*)[5] with diazomethane. The paraconate (I c), on treatment with butanolic potassium tert.-butoxide, and with methanolic sodium methoxide, followed by alkaline hydrolysis of the half-esters yielded the diacids (II *d*) and the paraconic acid (I *d*) respectively.

The difference in the behaviour of these two alkoxides can be attributed to an elimination (ring cleavage) of an ElcB type. The essentially planar five-membered ring (with eclipsed groups) makes the normal *trans* E2 elimination stereochemically difficult. The presence of a strong base aids the formation of the carbanion (IV), which formation is further helped by a negative carbomethoxyl group on a C_β carbon atom aiding the fission of the C-H bond[6] and also stabilizing the carbanion.

Paraconic esters have been postulated as intermediates in the Stobbe condensation.[7] The remarkable use of this reaction in synthetic organic chemistry since the discovery of potassium tert.-butoxide as a catalyst[8] (also refer Haworth *et al.*[9]) is probably due to this facile cleavage to itaconic systems (which are the predominant products when this catalyst is used) thus precluding side reactions.

EXPERIMENTAL

Methyl γ, γ-pentamethylene paraconate[1] (I *a*) (1·0 g.) was treated with potassium tert.-butoxide (from 0·30 g. of potassium and 10 ml. of anhydrous tert.-butanol) at room temperature (20°) for 15 min. in an inert atmosphere. The reaction mixture was poured into ice-cold water (40 ml.) and then washed with benzene (25 ml.) and ether (25 ml.). The alkaline phase on acidification with 6N-hydrochloric acid yielded *β - carbomethoxy - β-cyclohexylidene-propionic acid* (II *a*) (0·85 g.), crystals from ether-light petroleum (40-60°), m.p. 96-97°, eq. wt. 212·8, Found: C, 62·40; H, 7·36%. $C_{11}H_{16}O_4$ requires eq. wt. 212·2, C, 62·27; H, 7·55%). Alkaline hydrolysis of II *a* with 10% sodium hydroxide yielded cyclohexylidene-succinic acid, m.p. 179°.[1]

Dept. of Chemistry, K. RAGHAVA RAO.
Nagpur University, G. BAGAVANT.
Nagpur, *November* 19, 1968.

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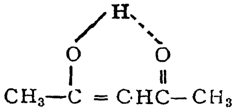
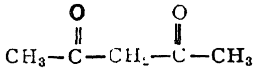
MOLECULAR ORBITAL CALCULATIONS ON THE TAUTOMERS OF ACETYLACETONE

THE tautomerism of acetylacetone has been extensively studied in the literature.[1] It is well documented that the enol form (I) is generally more stable than the keto form (II), although the relative proportions of the two forms vary with the medium. Even in the vapour phase,[2] acetylacetone exists in the enol form to the extent of 95% at 60° C. The heat of tautomerization determined by infrared spectroscopy in the vapour phase is 2·4 kcal/mole.[3]



(I)



$$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$$

(II)

Even though the tautomerism of acetylacetone is well understood experimentally, a molecular orbital calculation by Morokuma and co-workers[4] employing the extended Huckel (EHT) method of Hoffmann[5] has shown that the keto form is more stable than the enol form. This result is probably due to an inherent limitation of the EHT method, which does not account for electron repulsions. It was considered worthwhile to calculate the relative stabilities of acetylacetone by employing an approximate self-consistent molecular orbital method with complete neglect of differential overlap (CNDO/2) proposed by Pople, Santry and Segal.[6] This method neglects only the less important electron repulsion integrals. These calculations were carried out on IBM 7094 and CDC 6500 computers by assuming the geometry suggested by Ogoshi and Nakamoto[7] for the enol form of acetylacetone.

The total energies of the keto enol forms obtained by the CNDO/2 method were − 78·3778 a.u. and − 78·3815 a.u. respectively. It is interesting that the CNDO/2 method predicts the stability of the enol form, the energy of stabilization being 0·0037 a.u. or 2·3 kcal. This value for the energy of stabilization is in agreement with the experimental value of Powling and Bernstein.[3] Assuming additivity of bond energies in the keto and enol forms, it can be seen that the energy difference between the two forms is essentially the energy of the intramolecular hydrogen bond in the enol form. It may also be noted that the value 2·3 kcal is in the general range for the dissociation energies of hydrogen bonds.

The present results clearly show the superiority of the CNDO/2 method over the EHT method. The inclusion of electron repulsion terms is therefore very important. Other studies in this laboratory show the importance of the CNDO/2 method in correctly predicting the relative stabilities of the *cis*- and *trans*-forms of formic acid.[8] The CNDO/2 method seems to be more effective in predicting the dissociation energies and proton potential functions of hydrogen bonds.[8,9]

The author is thankful to Professor C. N. R. Rao for valuable suggestions and discussions, and to Professor R. E. Davis for his kind encouragement.

Dept. of Chemistry, A. S. N. MURTHY.
Indian Institute of Technology,
Kanpur, *November* 20, 1968.

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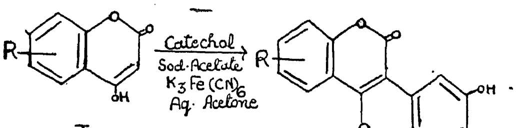
SYNTHESIS OF 11:12-OXYGENATED COUMESTANS

COMPOUNDS containing a 3-phenyl chroman carbon skeleton are abundant in nature and are known to exhibit marked physiological activity.[1] Coumestrol, a 3-aryl coumarin derivative isolated from ladino clover, exhibits considerable œstrogenic activity[2] and many members belonging to this group known as coumestans have recently been isolated mostly from medicinal plants.[3] Certain plants attacked by pathogens are known to produce coumestans[4] as protective agents from further attack and these are known as phytoalexins. Rao and coworkers[5] have shown that a halogen in 7-position of 3-aryl coumarins significantly enhanced their fish toxicity. The present communication deals with the synthesis of 11 : 12-oxygenated coumestans with a halogen in the main ring in different positions, since a system of this type with a 2′ oxygen involved in a ring has an identical side phenyl oxygenation pattern present in Rotenone.

Of the various methods[6-11] available for the synthesis of coumestans, the method due to Wanzlick,[11] involving the oxidative coupling of 4-hydroxy coumarin with catechol using $K_3Fe(CN)_6$ and sodium acetate in aqueous acetone medium appears to be suitable in view of the fact, that coumestans with a 11 : 12-oxygenation pattern required could be obtained directly in good yields in one step. The synthesis of a naturally occurring 7-hydroxy-11 : 12-dimethoxy coumestan[12] was reported earlier from these laboratories adopting this procedure. This method has now been extended to the synthesis of 6- and 7-substituted coumestans starting from appropriately substituted 4-hydroxy coumarins.

The intermediate 4-hydroxy coumarins required for the synthesis of these coumestans have been prepared by the Boyd-Robertson procedure[13] from the suitable substituted o-hydroxy acetophenones.

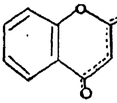
In general, the yields of the coumestans have been uniformly good and do not seem to depend on the substitution pattern of the 4-hydroxy coumarin.



(I)

(II)

R=Cl, Br, NH₂ or CH₃



(III)

The compounds synthesised have been listed in Table I with their U.V. spectral data. Table II gives the >C=O absorption of the coumestans along with those of the corresponding 4-hydroxy coumarins. While the >C=O absorption in coumestans is between 1710-1720 cm.$^{-1}$, in the corresponding 4-hydroxy coumarins it is around 1705 cm.$^{-1}$ In 4-hydroxy coumarins (I), there is considerable lowering of the normal lactone carbonyl possibly because of the 4-hydroxy coumarins existing in the dianion (III) state. However, it reverts back to its original position in cases where hydroxyl is involved in ether linkage (II) as the lactone carbonyl is stabilised. Rao and Lalitha have made a similar observation in the case of 3-phenyl 4-hydroxy coumarins.[14] The data presented in Tables I and II are consistent with the known behaviour of coumestans.[15]

All the compounds are very sparingly soluble and none of them show appreciable toxicity to fish. The five-membered furan ring involving the 2′ and 4 positions does not seem to contribute to the activity.

TABLE I

U.V.

Sl. No.	Coumestan	M.P.	U.V $\lambda_{max.}$	log ϵ
1.	6-Amino-11, 12-dimethoxy	182°	243 280 348	4·3 3 7 4·1
2.	7-Amino-11, 12-dimethoxy	216°	248 285 315 355	4·0 3·8 3·9 4·2
3.	6-Chloro-11, 12-dihydroxy	>360°	248 285 362	4·2 3·8 4·3
4.	6-Chloro-11, 12-dimethoxy	352°	248 284 360	4·1 3·8 4·2
5.	7-Chloro-11, 12-dihydroxy	>300°	247 285 348	4·2 3·8 4·3
6,	6-Bromo-11, 12-dihydroxy	>300°	247 285 358	4·1 3·8 4·2
7.	6-Methyl-11, 12-dihydroxy	>300°	244 285 347	4·2 3·8 4·3
8.	7-Methyl-11, 12-dihydroxy	294°	245 285 348	4·2 4·2 3·8
9.	7-Hydroxy-11, 12-dimethoxy	293°	246 280 305 350	3·9 3·5 3·6 4·0

TABLE II

I.R.

Name of the compound		4-Hydroxy coumarin >C=O absorption in cm.$^{-1}$ (Nujol)	11, 12-Dimethoxy coumestan >C=O absorption in cm.$^{-1}$ (Nujol)
1. 6-Acetamino	..	1708	1725
2. 7-Acetamino	..	1702	1720
3. 6-Chloro	..	1707	1720
4. 7-Chloro	..	1702	1720
5. 6-Bromo	..	1705	1720
6. 6-Methyl	..	1700	1710
7. 7-Methyl	..	1700	1720

One of the authors (M. D.) is grateful to the Government of India for the award of a Research Training Scholarship.

Dept. of Chem.,
Osmania Univ.,
Hyderabad-7,
November 20, 1968.

MALLESHWAR DARBARWAR.
V. SUNDARAMURTHY.
N. V. SUBBA RAO.

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PREPARATION OF THIOUREA COMPLEXES BY SOLID-SOLID INTERACTIONS

GENTILE and co-workers have recently reported on the utility of solid-solid interactions in the preparation of sydnones complexes,[1] urea complexes[2,3] and diacetamide complexes[4,5] of metal salts. We wish to report here the preparation of some thiourea (T) complexes of unusual structural interest by these techniques. Some of these complexes could be prepared otherwise only by tedious methods.

In a typical reaction, nickel sulphate heptahydrate and thiourea in 1 : 4 molar ratio were ground together in an agate pestle and mortar. The original green colour of the hydrated Ni^{2+} species disappeared gradually and was replaced by a dark blue colour. This new compound (A) was verified by X-ray and chemical analysis to be tetrakisthiourea nickel (II) sulphate prepared by another method given below. It is significant to point out here that this blue complex could not be isolated from aqueous solution containing nickel sulphate and thiourea at 30° C. Water is a much better ligand in aqueous solution than thiourea for Ni^{2+}. The phase equilibrium studies of the ternary system nickel sulphate-thiourea-water at 30° C. showed the existence of only nickel sulphate heptahydrate and thiourea as the solid phases. By evaporating large volumes of methanolic solutions containing the difficultly soluble nickel sulphate heptahydrate and excess thiourea a deep blue microcrystalline substance was precipitated out, which was analyzed after washing with methanol and ether. It was found to be tetrakisthiourea methanol nickel (II) sulphate. (Found: Ni, 11·82%; T, 62·2%; $NiSO_4.4T.CH_3OH$ requires Ni, 11·95%; and T, 61·97%). Heating this compound to 80° C. resulted in the formation of the new complex (B) analysing as tetrakisthiourea nickel (II) sulphate. The preparations A and B had identical X-ray, spectral and magnetic characteristics.

Several mixed thiourea-thiocyanate complexes of the type $[M_I T_4]$ $[M_{II} (NCS)_4]$ (M_{II} = Cd, Zn, Co, Ni, where M_I = Hg; M_{II} = Zn, Co, Ni, where M_I = Cd) were prepared by this technique.[6] The general technique involved intimate mixing and grinding of suitable proportions of appropriate finely powdered reactants, namely, the metal thiocyanate and thiourea in an agate mortar and pestle. Evidence for reaction was immediately observed in most of the cases of Co (II) and Ni (II) complexes through a change in colour of the mixture. The duration of grinding required for the preparation of about 2 g. of the product was 10 to 15 minutes. Chemical, spectral and X-ray examinations have been employed to confirm the completeness of the reaction.

The structures of $NiSO_4.4T$ and $NiSO_4.4T.CH_3OH$ appear to be very unusual and are being studied in detail. The two complexes show magnetic moments of zero and 2·59 B.M respectively at room temperature. The structural aspects of the complexes $[M_I T_4]$ $[M_{II} (NCS)_4]$ and the relative preferences of the metal ions for thiourea and thiocyanate ligands will be published elsewhere.

Dept. of Chemistry, M. Ramakrishna Udupa.
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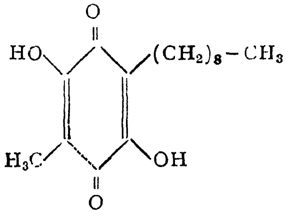
ISOLATION OF 'BHOGATIN' FROM *MAESA MACROPHYLLA* (WALL.) A.DC.

Maesa macrophylla Wall.[1] A.Dc. (Myrsinaceæ), native of Nepal, is locally known as Bhogati, and medicinally used for treatment of fevers, cough and ulcers. We report here the isolation of a new benzoquinone from the leaves of this **plant.**



(A)

Extraction of the dry leaves with *n*-hexane gave a red solid (A), (2·5%) which appeared as orange-red rectangular plates from benzene, which is named 'Bhogatin', a name derived from its Nepalese origin, m.p. 156-157°, u.v.: $\lambda_{max.}$ 295 mμ (log. ϵ 3·15) (ethanol), i.r. ($CHCl_3$): 3385 cm.$^{-1}$, 1635 cm.$^{-1}$, molecular weight 280, molecular formula $C_{16}H_{24}O_4$. It forms violet solutions with alkalies, a bluish-violet solution with concentrated sulphuric acid and a purple colour with alcoholic ferric chloride. It shows the properties of a quinone since it is readily reduced and easily reoxidised. It forms a diacetate, $C_{20}H_{28}O_6$, pale yellow prisms (from *n*-hexane), m.p. 63-64°, an acetate of its reduction product, $C_{24}H_{34}O_8$, colourless silky needles, m.p. 121-122° (from benzene and a di-2, 4-dinitrophenylhydrazone, $C_{28}H_{32}O_{10}N_8$, as dark red needles, m.p. 198-200° (from methanol). Oxidation using potassium permanganate gave *n*-decoic acid and acetic acid which indicates the presence of a methyl and *n*-nonyl groups. From these considerations, it is assigned the structure, 2, 5-dihydroxy-3-methyl-6-*n*-nonyl-1, 4-benzoquinone, (A). This constitution is further confirmed by a synthesis using capryl peroxide alkylation on 3, 6-dihydroxy-toluquinone to give 2, 5-dihydroxy - 3 - methyl - 6 - *n* - nonyl - 1, 4-benzaquinone, identical with the natural products and its derivatives.

The authors thank Dr. R. V. Tamhane of the Soil Conservation Research and Training Centre, Department of Agriculture, Government of India, New Delhi, and Mr. C. R. Rao, Botanist, for the collection of the plant materials.

Dept. of Chemistry, K. R. PRABHU.
Andhra Univ. Colleges, CH. B. RAO.
Waltair, V. VENKATESWARLU.
November 6, 1968.

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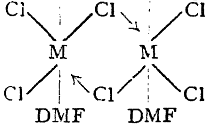
DIMETHYL FORMAMIDE (DMF) COMPLEXES OF LANTHANIDE CHLORIDES

IN a study of DMF complexes of lanthanide nitrates[1] and perchlorates,[2] we have found that while in nitrate complexes the anion is co-ordinated to the metal, the perchlorate ion is non-co-ordinating. It is of interest to extend the study to chloride complexes in order to assess the extent of co-ordination of chloride ion and the consequent effect on the co-ordination number of the lanthanides.

The complexes analyse for the formula $M(DMF)_2Cl_3$ where M = La, Ce, Pr or Nd (Table I). They are insoluble in solvents of low donor properties such as nitromethane, nitrobenzene, acetone and acetonitrile. Consequently, conductance and molecular weight measurements could not be carried out in these solvents. The complexes are, however, soluble in strongly co-ordinating solvents such as DMF and DMSO. In DMF, the complexes have a molar conductance in the range 90–95 $ohm^{-1}cm.^2$ $mole^{-1}$ corresponding to 1 : 1 electrolytic dissociation.[3] This suggests that probably one of the chlorines is differently bound from the other two. Molecular weight measurements in water show a 5-fold decrease of theoretical molecular weight showing that the complexes dissociate completely into their components in water. A structure involving halogen bridges is suggested for the chloride complexes which are thus believed to be six co-ordinate:



A similar structure has been proposed for the complex $BiI_3.2DMF$.[4] Bridge structures involving halogen have been postulated for DMSO complexes of lanthanide chlorides,[5] Cr^{II} halide adducts with DMSO[6] and dicyclopentadienyl lanthanide chlorides.[7]

The infrared spectra of the complexes are very similar with the carbonyl frequency at 1650 showing no significant dependence on the nature of the metal. The decrease in $\nu_{C=O}$ in the complexes compared with the free ligand value (1680) suggests that the amide co-ordinates to the metal through the oxygen.[1] Accordingly, the ν_{CN} and the N—C=O bending vibrations of the ligand (1090 and 660 $cm.^{-1}$ respectively) shift to higher values in the complexes (1115 and 675 $cm.^{-1}$ respectively).[1]

EXPERIMENTAL

Materials, Preparation and Analyses.—DMF (E. Merck LR grade) was purified as described in the literature.[8] Lanthanide oxides (99·9% pure) were from Lindsay Chem. Co., U.S.A. Cerous chloride (A.R.) was procured from Atomic Energy Commission, India.

The lanthanide chlorides were prepared by dissolving the oxides in aqueous solution of A.R. HCl. All were recrystallised from water. About 2–3 gm. of the chloride were dissolved in 5 ml. of DMF and the solution was subjected to prolonged desiccation (10–15 days) over P_2O_5. If necessary the excess solvent was pumped off avoiding contamination with moisture. The complexes were left behind as glistening hygroscopic crystalline powders.

The metal content was estimated by the oxalate-oxide method, chloride by Volhard's method and DMF by hydrolysis with NaOH and the subsequent acidimetric determination of dimethylamine[9] (Table I).

TABLE I
Analytical and conductivity data for $LnCl_3$-DMF complexes

Compound		% Metal	% Chloride	% DMF	λ_m in DMF Ω^{-1} cm.^{2} mole^{-1}
$La(DMF)_2Cl_3$	Calcd.	35·49	27·18	37·32	93·6
	Found	35·37	27·05	36·70	
$Ce(DMF)_2Cl_3$	Calcd.	35·70	27·11	37·25	94·0
	Found	35·65	27·01	36·40	
$Pr(DMF)_2Cl_3$	Calcd.	35·81	27·04	37·15	92·3
	Found	35·83	27·02	36·73	
$Nd(DMF)_2Cl_3$	Calcd.	36·36	26·82	36·84	93·0
	Found	36·02	26·26	36·59	

Conductivity, Molecular Weight and Infrared Studies.—The molar conductance of the complexes in DMF was determined in a Seimen's conductivity bridge at 30° C. using an immersion cell (Type LTA) previously calibrated with standard KCl solutions.

The molecular weights in water were determined by the Beckman's freezing point method.

The infrared spectra of the complexes were recorded in nujol mulls as well as in KCl pellets employing Carl-Zeiss UR-10 automatic infrared spectrophotometer.

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S. S. KRISHNAMURTHY.
S. SOUNDARARAJAN.

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STUDIES ON THE NUTRITIONAL VARIANTS OF THE CELL LINE MFS$_8$ CULTIVATED *IN VITRO*

MARKED differences have been noted between cells maintained under different conditions of nutrition. Keefe *et al.* (1965) working on alkaline phosphatase activity showed that L-M cells growing in medium 199 supplemented with peptone have moderate alkaline phosphatase activity as determined quantitatively. A variant of these cells growing in the chemically defined medium however had no measurable alkaline phosphatase activity.

In our laboratory, attempts are being made to maintain MFS$_8$ cells, derived from a mouse-fibrosarcoma in Eagle's medium BME (1955) without the use of serum. During the process, it has been possible to obtain variants of MFS$_8$, maintained in BME supplemented by varying amounts of horse serum (ES). These variants have been studied for their properties and the present communication describes the results on growth and some biochemical properties of these variants.

The variants used are (1) MFS$_8$-I maintained in BME supplemented with ES at 15% level, (2) MFS$_8$-II maintained in BME + 2% ES, (3) MFS$_8$-III maintained in BME + 1% ES and (4) MFS$_8$-IV maintained in BME + 0·5% ES. The variants have been maintained in respective media for more than 6 weeks (6 passages) before being used for studies. They were routinely maintained in 4 oz prescription bottles, fed every third day and transferred with the use of 0·25% trypsin solution. The cell count was taken by the method of Mashelkar and Wagh (1959). Growth was expressed in terms of growth index which was a ratio of nuclear number at the end of 72 hours growth and number of nuclei in the initial inoculum. For biochemical studies 48 hour cultures were used. Protein was determined by the method of Oyama and Eagle (1956). RNA and DNA were separated according to Waymouth (1951). RNA was estimated by measuring U.V. absorption at 260 mμ while DNA was extracted with hot perchloric acid according to the method of Cerroti (1955) and measured at 268 mμ.

Results of the growth and biochemical studies are given in Table I. The comparison of the growth index shows that MFS$_8$-I which was grown in media containing a very high amount of serum showed highest growth while other variants did not differ significantly in their growth rate. The DNA values also did not differ significantly. In case of RNA, however, the variant MFS$_8$-IV which was maintained at lowest amount of serum showed highest values and the values were significantly different from those obtained for MFS$_8$-I. It also appeared from the results that RNA per cell increased as the level of serum was brought down. Similar results were obtained with protein levels in different

TABLE I

Growth index, nucleic acid and protein levels in different variants

Variant	Growth index	DNA μg./10^6 cells	RNA μg /10^6 cells	Protein μg./10^6 cells
MFS$_8$-I	2·3	6·86 ±0·26 (10)	15·85 ±1·04 (10)	302·5 ±5·5 (10)
MFS$_8$-II	1·7	7·17 ±0·42 (12)	17·40 ±1·39 (12)	299·4 ±7·0 (12)
MFS$_8$-III	1·5	6·56 ±0·28 (10)	19·57 ±0·17 (10)	333·3 ±7·6 (10)
MFS$_8$-IV	1·7	6·09 ±0·34 (8)	20·40 ±0·79 (8)	335·8 ±7·9 (8)

Figures in brackets denote the number of samples studied.

variants. Protein per cell of MFS$_8$-IV was significantly higher as compared to that of MFS$_8$-I. The studies on alkaline phosphatase activities of these variants, as studied by the method of Frankel (1963) showed that none of these variants had detectable activity. It thus appears from the results that these variants though they do not differ significantly as regards their DNA content, show differences in their RNA and protein values.

Biology Division, A. S. SHIRODKAR.
Cancer Res. Institute, Parel, B. N. MASHELKAR.
Bombay-12,
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INDUCTION OF ROOT HAIRS ON GERANIUM PLANTS DIFFERENTIATED *IN VITRO*

THE *in vitro* production of plants from apical meristems, callus, and single cells is an important means of growing pathogen-free stock. Many investigators[1] have succeeded in getting shoots to differentiate from meristems or callus tissue cultured on agar media. However, roots often developed slowly[2,3] and, furthermore, the roots which grew into the agar media were devoid of root hairs. Such plantlets did not establish themselves easily when removed from the culture medium and planted in soil. A similar difficulty arose in our experiments to establish plantlets of geranium raised either from stem tip meristem cultures[4,5] or from differentiated callus tissue.[5] A moist chamber was found useful by White[6] as a means of getting root-tips of tomato cuttings. Similarly, a number of fiber-glass or filter-paper wick procedures have been devised to grow sterile plants or plant parts.[7-9] A simple modification of these same procedures is described which was found useful in inducing root and root hair formation on the isolated plantlets of geranium.

Test-tubes, 2 × 12 cm., were used as containers. Schleicher and Schuell's chromatographic filter-paper, grade No. 598, was cut into 1 × 9 cm. strips. Two layers of these strips were folded with a side length of 4 cm. leaving a platform or bridge of approximately 1 cm.^{2} in the middle. These filter-paper bridges were inserted into the test-tubes to support the cultured plantlets. The two layers of filter-paper were strong enough to stand erect and hold the weight of the plantlet.

The bridges were used either alone or with a small ball of absorbent cotton placed below the bridge (Fig. 1, A, B). Any one of several

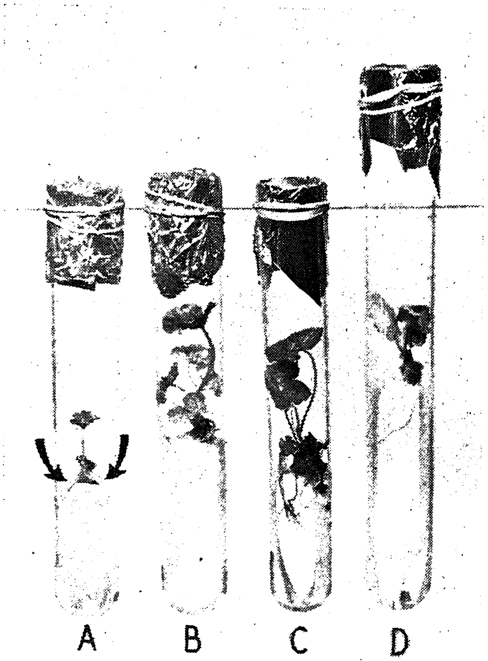

FIG. 1. The filter-paper bridge method. A. A plantlet of geranium, var. Pink Cloud, grown from a 1 mm. stem tip culture on a low filter-paper bridge with roots (arrows) showing abundant root hairs when in air but no root hairs in the medium in the absorbent cotton. B and C. Plantlets of the geranium var. Penny differentiated from callus and now growing on low filter-paper bridges with and without absorbent cotton. No root hairs formed on roots in the medium. D. A plantlet of the geranium var. Snow ball grown on a low bridge with hairless root and transferred to a high filter-paper bridge. The root hanging in the space between the bridge and the medium below developed root hairs at the tip after two days.

liquid nutrient media was poured to the level of the bridge—the "low bridge"—(Fig. 1, A, B, C); the mouth of the test-tube was covered with aluminum foil and the tubes were then autoclaved at 15 psi for 20 minutes. After cooling the test-tube, the plantlet was removed from the agar medium on which it was cultured and placed on the bridge. The mouth of the culture tube was again aseptically covered with the aluminum foil and the foil fastened with a rubber band. This prevented evaporation of the medium even after growing such cultures for more than a month. The plantlets produced roots in about 8 to 10 days; on agar, 20 days or more were required to get comparable growth. However, with the low bridge, the roots grew into the medium because the bridge was touching the medium, and hence did not produce root hairs (Fig. 1, B, C). If the roots grew in air, they produced abundant root hairs (Fig. 1, A). Therefore, longer filter-paper strips with a side length of 7 cm. were prepared and fitted into 2 × 15 cm. test-tubes. No cotton was used and the level of the liquid medium was reduced to a height of 2 cm. so that the bridges were 5 cm. above the liquid medium—the "high bridge" (Fig. 1, D). After sterilizing the test-tubes with the medium, the plantlets were cultured as before. The roots grew down in the space between the bridge and the surface of the medium and produced many root hairs.

Plantlets which had produced hairless roots in cultures on low bridges when transferred to high bridges often produced root hairs in 2 to 3 days, and occasionally in even one day after transfer (Fig. 1, D); 87·5% of such plantlets with root hairs survived on transfer to soil and grew into plants, whereas only 24% of plantlets survived before inducing root hair formation.

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Department of Botany, S. K. PILLAI.
Birla Institute of A. C. HILDEBRANDT.
Technology and Science,
Pilani, Rajasthan,
and
Department of Plant Pathology,
University of Wisconsin,
Madison, Wisconsin, 53706, U.S.A.,
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ELONGATION OF SINGLE CELLS BY DIFFERENT GROWTH REGULATORS AND CATIONS

ABSTRACT

Growth of single cells (tube of germinated pollen of *Lilium regale*) in optimum stimulating concentration of growth regulators and cations singly and in combination have been measured. Among the growth regulators, abscisic acid (ABA), hitherto supposed to be a growth inhibitor, induces maximum elongation, but it acts antagonistically to other growth regulators, except IAA, as also to cations and to White's nutrient solution. This antagonism may explain the role of ABA in dormancy and abscision processes.

TUBES of germinated pollen grains (single cells) offer special facilities for studying the effect of different solutions on growth elongation.[1] For measuring growth elongation of cells induced by growth regulators, fragments of coleoptile and hypocotyl are generally used, a technique entailing a considerable amount of time for measuring variations of growth in different solutions. On the other hand, changes in growth elongation of pollen tubes can be accurately measured under a microscope in a few hours.

Pollen grains of Regal lily (*Lilium regale*) have been used in the present experiments since they have been found to germinate in glass distilled water. This enables one to measure the effects of different pure solutions on growth elongation of pollen tubes. Regal lily pollen can be stored in a deep-freeze over a year without loss of germination or any diminution of length of pollen tubes. After growth in distilled water for 5 hours, the length of tubes of normal pollen grains of Regal lily was 33·0 ± 2·0 μ while the length of tubes of previously washed pollen was 22·4 ± 1·5 μ. To overcome the stimulating effect of substances adhering to pollen grains, only grains washed three times in distilled water have been used.

Washed pollen grains were germinated in three replicated drops of each solution in petri dishes with moist blotting-paper inside their covers.

Hourly measurements of lengths of pollen tubes at 25 ± 1° C. showed that the maximum rate of growth of Regal lily pollen takes place at the fifth hour. Data presented show the length of tubes 5 hours after germination. All pollen grains do not germinate simultaneously, however, and therefore only the five longest tubes in each of the three drops have been measured, with micrometer eye-piece (1 division = 20 μ). For each experiment an average of fifteen measurements is given as the length for the particular solution. The lengths of tubes in different solutions as shown in the tables are averages of the number of experiments given in brackets.

Lengths of pollen tubes in solutions of optimum concentrations of different growth regulators singly and in combination will be found in Table I.

These show that among the growth regulators ABA produces the longest tubes. Except IAA, other growth regulators GA_3, 2, 4-D and TIBA act antagonistically with ABA while combinations of IAA, GA_3, 2, 4-D and TIBA act synergistically.

Lengths of tubes in optimum concentrations of different cations and of White's nutrient solution are shown in the first column of Table II, and in subsequent columns, in combination with IAA, GA_3, TIBA and ABA.

It will be seen that the maximum tube-lengths are obtained in White's nutrient solution. In all combinations with IAA, except Ca, the lengths of the tubes increase. With GA_3 all the cations act additively. In the case of TIBA no significant difference could be observed in combination with K and Mg. In the case of ABA in combination with White's nutrient solution there was marked reduction of tube-lengths, whereas in combination with Ca, K and Mg, the lengths of tubes in ABA were shorter.

Effects of growth regulators have recently been reviewed[2-4] and the general conclusion is that ABA counteracts the effects of IAA and GA_3. Working with Sycamore dormin[5] it was shown that ABA, whose identity with dormin has been established,[6] is a gibberellin antagonist. This finding is in agreement with our data that IAA in combination with ABA has no detectable effect, while in combination with GA_3 tube-lengths are markedly reduced. Among the growth regulators tried, abscisic acid produces the longest tubes but in combination with different cations and White's nutrient solution the tube-lengths are markedly reduced. This antagonism may explain the function of ABA on induction of dormancy and in the abscission-accelerating process.

TABLE I

Tube-lengths of Regal lily pollen grown in optimum concentration of different growth regulators singly and in combinations

(Number of experiments for each treatment is given in brackets)

Treatments	Tube-lengths × 20 μ	Treatments	Tube-lengths × 20 μ
Water	22·4 ±1·5 (60)	IAA + TIBA	40·9 ±0·6 (15)
0·1 ppm. IAA	38·5 ±1·6 (30)	GA_3 + 2, 4-D	45·7 ±1·0 (15)
70 ppm. GA_3	42·0 ±1·0 (30)	GA_3 + TIBA	44·3 ±1·2 (15)
0·05 ppm. 2, 4-D	38·0 ±0·5 (20)	2, 4-D + TIBA	41·6 ±1·2 (15)
0·5 ppm. TIBA	38·8 ±1·5 (15)	IAA + ABA	48·8 ±1·3 (20)
6 ppm. ABA	48·0 ±1·0 (30)	GA_3 + ABA	38·7 ±0·9 (20)
IAA + GA_3	46·8 ±0·8 (20)	2, 4-D + ABA	43·0 ±1·3 (20)
IAA + 2, 4-D	42·4 ±1·2 (15)	TIBA + ABA	39·5 ±1·1 (15)

TABLE II

Tube-lengths of Regal lily pollen grown in combination of different ions and growth regulators: Ca as in $Ca(NO_3)_2 . 4H_2O$; K as in KNO_3; Mg as in $MgSO_4 . 7H_2O$

Water	0·1 ppm. IAA	70 ppm. GA_3	0·5 ppm. TIBA	6 ppm. ABA
Tube-lengths × 20 μ	Tube-lengths × 20 μ	Tube-lengths × 20 μ	Tube-lengths × 20 μ	Tube-lengths × 20 μ
22·4 ± 1·5 (60)	38·5 ± 1·6 (30)	42·0 ± 1·0 (30)	38·8 ± 1·5 (20)	48·0 ± 1·0 (30)
5 ppm. Ca 39·9 ± 2·2 (30)	40·0 ± 0·9 (20)	48·8 ± 0·8 (20)	42·0 ± 0·8 (20)	40·0 ± 1·0 (20)
85 ppm. K 37·8 ± 1·2 (20)	43·9 ± 1·6 (15)	50·0 ± 1·8 (15)	39·1 ± 1·3 (15)	37·5 ± 1·2 (15)
5 ppm. Mg 40·0 ± 1·0 (20)	43·4 ± 1·3 (15)	48·0 ± 1·8 (15)	39·8 ± 1·2 (15)	39·3 ± 1·4 (15)
White's nutrient 77·2 ± 2·8 (20)	88·0 ± 2·3 (10)	102·5 ± 3·1 (10)	95·0 ± 2·8 (10)	57·2 ± 1·9 (10)

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VARIATIONS IN STEROL AND STEROL ESTERS DURING DEVELOPMENT OF *DYSDERCUS KOENIGII* (HEMIPTERA)

Insects have a requirement for sterol in the diet and bulk of it is utilized as an element of the cellular structure.[1] Sterols seem to play a similar role in insects, as cholesterol does in mammals.[1] Insect hormone, ecdysone is a steroid, and the brain hormone and juvenile hormone are also believed to be steroidal in nature.[2] It has been shown that the sterol content of the insects studied remains relatively constant during development.[2,3] However, sterols are present in the insects as free sterols and sterol esters which seem to have different roles to play.[2] No effort has been made to study the relative contents of the free sterols and sterol esters during insect development. Results of such an investigation on *Dysdercus kœnigii* (F) are presented in this communication.

Materials and Methods

The various life stages of *D. kœnigii* were drawn from a laboratory culture maintained on cotton seeds and water at 27–28° C. Each stage was collected for sterol extraction 24 to 48 hours after moulting. Eggs were used 24 to 48 hours after oviposition. Sterols were extracted from weighed insects by acetone-alcohol (1-1) and the extraction repeated three times. The total and free sterols were determined by digitonin precipitation and Liebermann-Burchard color reaction.[4] Each experiment was replicated at least six times. The sterol ester content was obtained by subtracting the value of free sterol from total sterol.

Results and Discussion

The results are presented in Table I. The second instar consisted of about 0·055% total sterol which gradually increased to about 0·093% in the adults. The sterol content was also high in the eggs, being about 0·082%. Thus a difference in the sterol content was noted as contrasted to the findings of earlier workers in insects.[3,5,6] The proportions of sterol esters and free sterols also showed some variations. Of the total sterols, free sterol content in the second instar was highest, about 77%, the lowest being in the fourth instar, about 60%. The percentage of sterol ester in whole insects varies from about 10 to 40,[2] which is in agreement to the results presented. It has been suggested that the sterol esters are stored in the fat body of the growing insect to be used later during maturation or for egg production.[7] The free sterol, specially cholesterol, has an essential role in the structure and maintenance of the cell membrane.[1] Cholesterol is also precursor of at least one insect hormone, ecdysone.[8] Sterols and their metabolites may also be excreted.[1] The significance of the variations in the sterol content during development is yet to be elucidated.

Table I

Sterol and sterol ester content of various life stages of D. kœnigii

Stage	Total sterol	Free sterol		Sterol ester	
	µg/gm.*	µg/gm.*	Per cent †	µg/gm.*	Per cent †
Egg ..	822·4 ±12·5	619·3 ± 4·8	75·3	203·1	24·7
First instar	768·3 ±19·0	526·2 ±5·95	68·5	242·1	31·5
Second „ ..	552·0 ±11·4	426·5 ±23·4	77·3	125·5	22·7
Third „ ..	659·2 ±15·4	454·0 ±12·7	68·9	205·2	31·1
Fourth „ ..	737·1 ±13·5	438·9 ±11·6	59·5	298·2	40·5
Fifth „ ..	822·8 ±20·5	548·8 ±14·1	66·7	274·0	33·3
Adult ..	931·8 ±19·6	579·3 ± 6·2	62·2	352·5	37·8

* µg/gm. of fresh weight of insects. † Per cent of total sterol

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Dept. of Zoology, HARI C. AGARWAL.
University of Delhi,
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ON THE OCCURRENCE OF THE PEA-CRAB *PINNOTHERES* SP. IN THE MANTLE CAVITY OF THE GASTROPOD *TURBO INTERCOSTALIS* (MENKE)

WHILE engaged in the study of the biology of a common intertidal marine gastropod, *Turbo intercostalis* (Menke) of the Waltair coast we came across a pea-crab *Pinnotheres* sp. in the mantle cavity of a single specimen of the host. The crab was alive and performed active movements when transferred to sea-water from the mantle cavity of the host.

While pinnotherids have been reported from a number of bivalve molluscs previously, this is the second report, as far as we are aware, of the occurrence of the crab in a gastropod. Sugiura *et al.* (1960) found *Pinnotheres gorodoni* in a variety of bivalves at Kisarazu (Japan) and in a single instance in the gastropod, *Umbonium* (*Suchium*) *moniliferum*. Recently, reviewing the literature on the parasitisation by the pea-crab *Pinnotheres* sp. Silas and Algarswami (1965) observed that the occurrence of a pea-crab in a gastropod is most unusual. Unfortunately, the exact location of the crab in the mantle cavity of the gastropod could not be ascertained as its presence was totally unexpected. It may, however, be stated that it occurs deep down in the mantle cavity as some portion of the mantle had to be cut open before the crab came out.

In the present instance the host is a female of 41 mm. shell-height, with an opercular opening of 15·1 mm. The crab is also a female having a carapace of 8·4 mm. breadth and 6·2 mm. length.

Although we have examined several hundreds of the host there has not been any other instance of parasitisation by the crab. It is, therefore, presumed that the present instance may be purely an accidental entry of the crab into the gastropod host.

Department of Zoology, P. N. GANAPATI.
Andhra University, R. V. RAMA SASTRY.
Waltair, *September* 9, 1968.

---

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ALTERATION IN THE RATE AND SPECTRUM OF CHLOROPHYLL MUTATIONS INDUCED BY ETHYL METHANE SULPHONATE IN WHEAT

THE studies of Stadler,[1] Froier,[2] MacKey[3] and Sears[4] suggest that in hexaploid wheat several genes control chlorophyll development. The absence of chlorophyll deficient types amongst the 21 nullisomics of *T. æstivum* variety Chinese Spring supports this view and makes it evident that the various genes responsible for chlorophyll development in hexaploid wheat are located in two or more different chromosomes. Unless these various genes are affected simultaneously or a mutation to an allele with divergent function[5] occurs, chlorophyll mutations cannot find phenotypic expression. During the course of mutation studies on the six commonly recognised hexaploid *Triticum* species treated with various doses of the physical mutagens X-rays, gamma-rays, beta particles from P^{32} and S^{35}, and the chemical mutagen, ethyl methane sulphonate (EMS), several chlorophyll mutations were observed in the M_2 generation besides other visible mutations. The relative incidence of different types of chlorophyll mutation varied in EMS and radiation treatments and this aspect of the study is described here.

Among the large control population grown, no spontaneous chlorophyll deficient types occurred whereas various types of chlorophyll mutations occurred among the progenies of treated plants, though at a low frequency. The frequency of chlorophyll mutations observed in the M_2 generation of the six hexaploid *Triticum* species treated with the various mutagens is presented in Table I. The mutation rate is expressed as the percentage of M_2 families egating for chlorophyll mutations. Since M$_2$ family had only one type of chloro-ll mutation, the figures also represent the centage of mutations per M$_2$ family. It can seen from Table I that treatment with the mical mutagen, ethyl methane sulphonate, erally resulted in a higher frequency of orophyll mutations than treatment with the ious physical agents. These results are in ord with those of Heslot *et al.*,[6] Ehrenberg *al.*[7] and Swaminathan *et al.*[8] in demonstra- the extraordinarily high potency of EMS inducing chlorophyll mutations.

TABLE I

quency of chlorophyll mutations induced by adiations and ethyl methane sulphonate in hexaploid species of Triticum

Species	Frequency of chlorophyll mutations induced by	
	Radiations	EMS
estivum Pb.C. 281	0·30*	0·99
compactum C. 28 ..	0·59	2·91
sphærococcum C. 40	..	1·76
spelta E. 15 ..	..	..
macha E. 300 ..	..	2·17
vavilovi E. 78 ..	..	..

* Percentage of M$_2$ families segregating for chloro-hyll mutations.

Among the M$_2$ progeny of *T. æstivum* var. .C.281 treated with radiations only *albinas* urred whereas in the treatment with EMS, y *viridis* and *xantho-viridis* types of chloro-yll mutants were observed. In the case of *compactum, virido-albina, albo-viridis, tho-viridis, striata* and *tigrina* type chloro-yll mutants were scored. In the case of *sphærococcum* and *T. macha*, chlorophyll tations were obtained only in the progenies EMS-treated plants and these were all of *tho-viridis* and *albo-viridis* type. No chloro-yll mutants occurred in the M$_2$ progenies of *spelta* and *T. vavilovi*. D'Amato *et al.*[9] rking with *durum* wheat reported that h both DS (diethyl sulphate) and EMS, the quency of *albina* is clearly reduced in our of *xantha* and other mutation types of stafsson's[10] *viridis* group. The finding of renberg *et al.*[7] that ionizing radiations duce relatively more *albina* and less *viridis* d other rare types of chlorophyll mutations comparison with chemical mutagens is also firmed by the results of the present study able II). They suggested that such a ective mutagenic effect may arise from a non-random action of the chemical on chromosomes.

TABLE II

Number of chlorophyll mutations induced by radiations and EMS in hexaploid Triticum *species*

Species	Treatment	No. of M$_2$ families studied	Number of chlorophyll mutations of type	
			Albina	Others
T. æstivum Pb.C. 281	Radiations	338	1	..
	EMS	203	..	2
T. compactum C. 28	Radiations	337	..	2
	EMS	172	..	5
T. sphærococcum C. 40	Radiations	333	..	..
	EMS	170	..	3
T. spelta E. 15 ..	Radiations	346	..	..
	EMS	114	..	..
T. macha E. 300 ..	Radiations	190	..	..
	EMS	92	..	2
T. vavilovi E. 78 ..	Radiations	147	..	..
	EMS	87	..	..

Biology Division, M. V. PRABHAKARA RAO.
Bhabha Atomic
Research Centre, Trombay,
Bombay-74, *July* 26, 1968.

---

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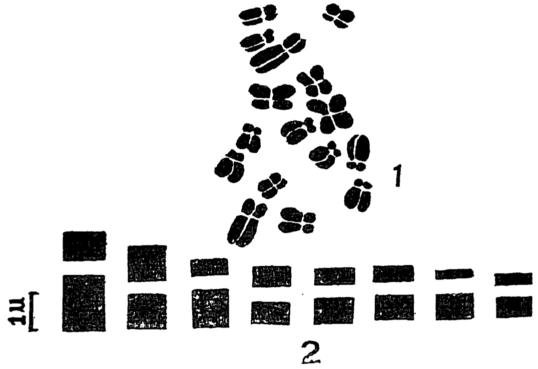
THE KARYOTYPE OF *JUSSIAEA SUFFRUTICOSA* LINN.

THE genus *Jussiœa* Linn. is included in the tribe Jussiææ of the family Onagraceæ along with three other genera, *viz.*, *Ludwigia, Isnardia* and *Oocarpon*. The Onagraceæ is a small family and has long been of cytogenetic interest on account of the existence of permanent translocation heterozygotes in the tribe Onagreæ. In India, the genus *Jussiœa* is represented by two species: *J. repens* Linn. and *J. suffruticosa* Linn. Of these two species it is only in *repens* that both gametic and somatic studies have been made and the chromosome number of $n = 8$ and $2n = 16$ has been reported by Sinoto (1928) and Sharma and Sarkar (1956). In India the species *suffruticosa* has not been studied cytologically so far. The only available cytological reports on this species are by Gregory and Klein (1960) and Chuang (1963) but these reports concern only the gametic number, the former authors reporting $n = 16$ and the latter $n = 24$. Karyotype studies in this taxon both in India and elsewhere are wanting. The present investigation is therefore aimed at filling this gap in our knowledge of this species.

Full plants growing under marshy conditions were collected from the surrounding areas of Bangalore (S. India) and transplanted in the University Botanical Garden. The innumerable extremely small seeds from mature capsules were collected and germinated in petri dishes for the root tips. Great care was necessary to handle and process the material owing to the smallness of the seeds and the root tips. Excised root tips were pretreated with 8-hydroxy-quinoline (0·002 M) for about 4 hours at about 10° C. They were fixed in Carnoy's (acetic-alcohol-chloroform) for 24 hours and then squashed in 3% acetic-orcein following customary procedure. After temporary sealing with a mixture of gum-mastic and paraffin the slides were studied after two days. Because of the paucity of divisions and difficulty in getting properly scattered chromosomes a large number of slides had to be prepared in different seasons of the year. These studies have revealed the somatic chromosome number of the species as $2n = 16$ ($n = 8$) and this number fits in very well with the chromosome number of the investigated species. Figure 1 shows the 16 somatic metaphase chromosomes and Fig. 2 is the idiogram of the complement. The chromosomes are very small, ranging between 0·74 μ and 2·06 μ in their length. Table I gives the measurements of the chromosomes and the absolute length is 9·71 μ. The karyotype consists of 8 pairs of chromosomes of which only one pair is with median constrictions and the rest are either with sub-median or sub-terminal constrictions. Although nucleolar chromosomes could not be detected owing to the small size of the chromosomes, the organization of two clear nucleoli in each of the mitotic telophasic nuclei is indicative of the diploid nature of this species. The occurrence of these populations with $2n = 16$ ($n = 8$) in India throws significant light on the evolutionary pattern of this taxon. If $n = 8$ is taken as the basic chromosome number for this species the distribution pattern in terms of ploidy would be diploids in India ($n = 8$), tetraploids in U.S.A. ($n = 16$) and hexaploids in Taiwan ($n = 24$).



FIGS. 1-2. Fig. 1. Somatic chromosomes, × 2,910. Fig. 2. Idiogram of the somatic complement.

TABLE I

Measurements of the chromosomes of Jussiæa suffruticosa

Pairs	L.A. in μ	S.A. in μ	Total in μ	Relative length	Index
1	1·40	0·66	2·06	21·21	0·47
2	0·82	0·82	1·64	16·89	1·00
3	0·99	0·41	1·40	14·32	0·41
4	0·57	0·50	1·07	11·03	0·87
5	0·66	0·33	0·99	10·20	0·50
6	0·66	0·33	0·99	10·20	0·50
7	0·66	0·16	0·82	8·44	0·24
8	0·49	0·25	0·74	7·62	0·51
			9·71		

The authors wish to record their thanks to Professor M. Nagaraj for his interest in this work.

Department of Botany, A. SHERIFF.
Bangalore University, N. MAHALAKSHMI.
Central College,
Bangalore, *September* 17, 1968.

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REVIEWS AND NOTICES OF BOOKS

Advances in Chromatography (Vol. 6). Edited by J. Calvin Giddings and Roy A. Keller. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xix + 339. Price $ 16.75.

In this sixth volume of *Advances in Chromatography,* as in all volumes of this series, critical, current surveys of the important advances in the respective areas of chromatography, written by noted authorities in chromatographic science, are presented.

The subject-matter in this volume has been dealt with in two parts, *viz.,* General Chromatography and Gas Chromatography. The first part contains the following articles: The Systematic Use of Chromatography in Structure Elucidation of Organic Compounds by Chemical Methods, by Jiri Gasparic; Polar Solvents, Supports, and Separation, by John A. Thoma; Liquid Chromatography on Lipophilic Sephadex: Column and Detection Techniques, by Jan Sjovall, Ernst Nystrom, and Eero Hahti.

The second part, Gas Chromatography, contains the following articles: Statistical Moments Theory of Gas-Solid Chromatography: Diffusion-Controlled Kinetics, by Otto Grubner; Identification by Retention and Response Values, by Gerhard Schomburg; The Use of Liquid Crystals in Gas Chromatography, by H. Kelker and E. von Schivizhoffen; and Support Effects on Retention Volumes in Gas-Liquid Chromatography, by Paul Urone and Jon F. Parcher. C. V. R.

Monoclonal and Polyclonal Hypergammaglobulinemia: Clinical and Biological Significance. By J. G. Waldenstrom. (Cambridge University Press), 1968. Pp. viii + 223. Price 55 *sh.* net.

The author is now particularly concerned with the correlation of the clinical and the biological significance of the immunoglobins—the proteins of the antibody system, of which the gamma globulins are the major fraction. This book reviews the many advances which have taken place in this field over the last decades.

Much fundamental medical knowledge has been obtained by careful analysis of variations in clinical conditions which could not have been produced experimentally. Thus, the analysis of the gamma globulins has been largely based on observations of abnormal conditions such as macroglobulinemia and hypergammaglobulinemia.

The division of the hypergammaglobulinemia into two main groups, monoclonal and polyclonal, is based on the associated diseases. In the former group, only one cell line is proliferated; in the latter, there are a large number of different lines producing gamma globulins.

The author relates these abnormalities of the blood proteins to known states such as the autoimmune diseases and quotes case histories he has himself investigated. He also considers the underlying genetic, biochemical, physiochemical, and serologic implications of this work and discusses its relevance to metabolic derangements in myeloma and other malignancies.

This book will be of interest to protein biochemists, immunologists, serologists, and clinicians concerned with the diagnosis and treatment of malignant and collagen diseases.

C. V. R.

Annual Review of Astronomy and Astrophysics (Vol. 6). Edited by Leo Goldberg. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. vii + 528. Price: U.S.A. $ 8.50; Elsewhere $ 9.00.

Volume 6 of the *Annual Review of Astronomy and Astrophpsics* was organized by the Editorial Committee during its sixth meeting held at the Kitt Peak National Observatory in Tuscon, Arizone, on May 28, 1966. Dr. Andrew Pacholzyk of the Steward Observatory attended as a guest and made many valuable suggestions.

The articles contained in this volume are: Electronic Image Intensification, by W. Kent Ford, Jr.; Measurement of Stellar Diameters, by R. Hanbury Brown; The Wolf-Rayet Stars, by Anne B. Underhill; Observed Properties of the Interplanetary Plasma, by Norman F. Ness; Statistics of Solar Active Regions, by Constance Sawyer; Structure and Dynamics of the Interstellar Medium, by S. B. Pikel'ner; Intergalactic Matter, by Robert J. Gould; Interstellar Dust, by Beverly T. Lynds and N. C. Wickramasinghe; The Counts of Radio Sources, by M. Ryle; The Physics of Comet

Tails, by John C. Brandt; The Dynamics of Planetary Rotations, by Peter Goldreich and Stanton J. Peale; Radio Spectra, by P. A. G. Scheuer and P. J. S. Williams; White Dwarfs, by Volker Weidemann; Observational Techniques in X-Ray Astronomy, by R. Giacconi, H. Gursky, and L. P. Van Speybroeck; Variable Radio Sources, by K. I. Kellermann and I. I. K. Pauliny-Toth; Theoretical Atomic Transition Probabilities, by David Layzer and Roy H. Garstang; and Some Related Articles Appearing in Other *Annual Reviews*. C. V. R.

Living for Life: The Interplay Between Agriculture and Science. (Pudoc, Publishing Department, Centre for Agricultural Publications and Documentation, P.O. Box No. 4, Wageningen, the Netherlands), Pp. 165. with 120 plates, Dfl. 25.

This beautiful publication in word and picture has been produced for the Golden Jubilee of the Agricultural University of Wageningen. Wageningen, a small town on the Rhine, has become a symbol of Dutch University education and research in Agriculture. The Jubilee volume aims at an insight into contemporary agricultural research and its sidelines. It will be an enjoyment, as well as education, to go through the pages and plates of this Souvenir volume depicting the development of agricultural research in the Netherlands and elsewhere in the world. The photographs illustrate work in fields and laboratories. Two pictures refer to India, p. 89 rice research in Cuttack, and p. 73 soil research in Purma. Ir. D. J. Maltha, Director, Pudoc, has written the introductory text and the running commentary to the plates. A. S. G.

Manual of Field Geology. By Robert R. Compton. (Wiley Eastern Private Limited, Publishers, J 41, South Extension 1, New Delhi-3), 1968. Pp. 378. Price Rs. 11·50.

This popular book on Field Geology, first published in 1962 at $7.50, is now made available to students as a low cost Indian edition at Rs. 11·50 only.

The primary object of the author in writing this book was to enable undergraduate students to do their field-work in geology without much supervision. For this purpose the author has described in great detail the basic procedure of observation, interpretation, mapping and reporting. The first eleven chapters deal primarily with techniques and basic concepts of field-work. The remaining four chapters are intended to help students attack specific problems and are respectively concerned with field-works with sedimentary, volcasic, plutonic, and metamorphic rocks. Over 150 drawings illustrate important outcrop-size structures and relations. A. S. G.

General Entomology. By M. S. Mani. (Oxford and IBH Publishing Co., 17, Park Street, Calcutta-16), 1968. Pp. xii + 501. Price Rs. 18·00.

This publication which has been prepared with care and thoroughness is likely to establish itself as a standard text-book on entomology for graduate and honours students of the subject.

The book is in two parts of almost equal length. The General Part describes in five chapters the main features of insect zoology, the body organizations and functions, development and growth, insects and their environments, and insects distribution in space and time. The second part on Systematic Entomology deals with the classfication of insects and treats in seventeen chapters with the various orders of the insects. The presentation in each order is for the special structural and functional modifications of the group as a whole, rather than of a particular type species.

The book well got-up and moderately priced, contains 130 text-figures, each planned to give maximum information possible. A. S. G.

Books Received

Cryogenic Properties of Polymers. By Tito T. Serafini and J. L. Koenig. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1968. Pp. x + 302. Price $13.75.

Fundamental University Physics (Vol. III)—*Quantum and Statistical Physics.* By M. Alonso and E. J. Finn. (Addison Wesley Pub. Co., Inc., London W. 1), 1968. Pp. ix + 598. Price 67 *sh.*

Tropical Crops-Dicotyledons. By J. M. Purseglove. Part I, Pp. xiv + 332; Part II, Pp. viii + 333–719; (Longmans Green and Co., Ltd., London W. 1), 1968. Price 50 *sh.* each.

Hand-Book of Methods of Tests for Cotton Fibres, Yarns and Fabrics. By V. Sundaram and R. L. N. Iyengar. (Indian Council of Agricultural Research, Krishi Bhavan, New Delhi), 1968. Pp. xvi + 175. Price Rs. 10·00.

794-68. Printed at The Bangalore Press, Bangalore City, by M. S. Narayanamurthy, Secretary, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

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THE INDIAN ACADEMY OF SCIENCES: XXXIV ANNUAL MEETING

THE Thirty-fourth Annual Meeting of the Indian Academy of Sciences was held on the 22nd, 23rd and 24th December, 1968 in Ahmedabad at the invitation of the Physical Research Laboratory, Ahmedabad. The inaugural function was held on the 22nd evening at the Tagore Hall before a large gathering of Fellows, scientists and distinguished public. Dr. Vikram A. Sarabhai, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Government of India delivered the Welcome Address. After introduction of the Fellows of the Academy present at the session, the President Sir C. V. Raman, Nobel Laureate, delivered the Presidential Address on "Floral Colours and their Origins".

Dr. Raman said that a very wide range of floral colours arises from the presence of a set of discrete and well-defined bands in the absorption spectra of the flower petals. Thus all flowers exhibiting colours ranging from the palest blue to the deepest violet, show three distinct absorption bands respectively in the red, yellow and green regions of the spectrum. Likewise, flowers exhibiting colours ranging from a reddish-purple to crimson red exhibit three well-separated bands respectively in the yellow, green and greenish-blue regions of the spectrum. He has named the pigments present in the flower petals having these properties as Florachrome-A and Florachrome-B respectively. In many cases these pigments can be readily extracted from the flower petals by simple immersion in acetone. The extracts exhibit the same absorption spectra as the flowers and retain their colours for fairly long periods without fading away.

According to present ideas floral pigments are identified with one or another of the class of substances known as anthocyanins. The extraction and purification of these anthocyanins involve the treatment of the flower petals with acids, and their absorption spectra as reported bear no resemblance to the observed spectra of Florachrome-A or Florachrome-B. It is difficult in the circumstances, said Dr. Raman, to accept anthocyanins with the structures assigned to them, as being truly the pigments responsible for the observed colours of the flowers.

The joint scientific meetings under Sections A and B were held on the 23rd and 24th in the lecture theatre of the Physical Research Laboratory. The forenoon session on the 23rd was presided over by Prof. T. S. Sadasivan, Director, University Botany Department, Madras, who addressed the gathering on "Osmoregulation in Pathogenesis". This was followed by an illustrated lecture by Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi, on "The Genetic Betterment of Yield and Quality in Food Crops". Then two papers were presented, the first on "Effect of Pressure on Optical Rotatory Power" by Dr. S. Ramaseshan, Head of the Material Sciences Division, National Aeronautical Laboratory, Bangalore, and the second on "Meteorites as Probes for Studying the Archæology of Cosmic Rays" by Prof. D. Lal of the Tata Institute of Fundamental Research, Bombay.

The afternoon session under the Chairmanship of Prof. T. R. Seshadri of Delhi University, started with his address on "A Line of Development in the Chemistry of Natural Products". This was followed by a talk on "Meteorological Instrumentation for Atmospheric Studies" by Miss Anna Mani, Director (Instruments), Meteorological Department, Poona. Dr. C. Ramaswamy, Retired Director-General of Observatories, spoke on "The basic causes of large-scale deficiency in the South-west Monsoon Rainfall over India in 1965 and 1966". Dr. N. A. Narasimham, Head of the Spectroscopic Division, Bhabha Atomic Research Centre, Bombay, gave an account of some recent developments on Electronic Spectra of Simple Molecules".

In the evening public lecture held in the Senate Hall of the Gujarat University, Prof. G. N. Ramachandran, Centre of Advanced Study in Biophysics, University of Madras, spoke on "Molecular Biology". Prof. Ramachandran discussed the relationship between structure and function of biological macromolecules in the light of the data that have come to be known within the last decade or so. In these large molecules the primary structure alone is not sufficient to define the nature of the factor responsible for biological activity. Secondary and tertiary structures, based on the folding of the chains play a vital part. Studies on physical chemistry and molecular physics have thrown much light on the nature of mechanism of this folding. X-ray crystallographic studies have also revealed much information on the types of folding that take place. Prof. Ramachandran also explained the nature of the fold in proteins, in nucleic acids and in polysaccharides in relation to their biological function.

On the 24th the forenoon session was held under the Chairmanship of Prof. G. N. Ramachandran. The opening lecture was by Dr. M. G. K. Menon, Director, Tata Institute of Fundamental Research, Bombay, who spoke on "Recent Work in Muon and Neutrino Physics". This was followed by an interesting talk on "High Pressure Phenomena in Solids" by Dr. A. Jayaraman of the Bell Telephone Laboratories, New Jersey. Prof. C. N. R. Rao, Indian Institute of Technology, Kanpur, spoke on "Charge-Transfer Spectra and Organic Semiconductors". Prof. S. Chandrasekhar of Mysore University gave an account of a recently developed theory on "Optical Properties of Cholesteric Liquid Crystals". Dr. Satya Prakash of the Physical Research Laboratory discussed a paper on "Study on Plasma Noise in the Lower Ionosphere using Rocket-borne Langmuir Probe and Plasma Noise Probe".

In the afternoon session of the 24th, Chairman Dr. N. K. Panikkar, Director, National Institute of Oceanography, spoke on "Crustacean Physiology in relation to Prawn Culture". The following three papers were presented and discussed: "Chief Factors which control Activity of the Southwest Monsoon over the Indian Sub-continent" by Dr. B. N. Desai; "Adaptation of Gene Erosion in Some Crop Plants" by Dr. B. R. Murthy; and "X-Ray Flux from Celestial Sources" by Dr. U. R. Rao. There was an evening public lecture on "Recent Studies on Some Nutritional Disorders" by Dr. C. Gopalan, Director, Nutrition Research Laboratories, Hyderabad.

As this year of the Academy's Annual Meeting marked the 80th Birthday of its President Sir C. V. Raman, a special banquet was held on the 23rd at which felicitations were offered to him. A tastefully got-up Souvenir Album containing the signatures of the Fellows of the Academy was presented to Sir C. V. Raman to mark the occasion.

ABSTRACTS OF PAPERS PRESENTED AT THE 34TH ANNUAL MEETING OF THE INDIAN ACADEMY OF SCIENCES AT AHMEDABAD

Osmoregulation in Pathogenesis

T. S. Sadasivan
University Botany Laboratory, Madras-5

One of the very early events in pathogenesis of bacterial, fungal and viral diseases of plants is a disturbance in osmoregulation. This is a consequence of the establishment of nutritive relationship by parasite with the host tissues. In obligate parasite-susceptible host combinations, the parasite, whether a rust or a virus, puts a heavy stress on nitrogen at cellular or sub-cellular level. An interesting case has been reported recently of a rust of bean recalling nitrogen compounds from the root in large quantities in a susceptible variety. In the case of facultative parasites there are even more adverse consequences.

Extracellular toxins/enzymes of pathogens diffuse out from infected areas and alter permeability. Pectic enzymes of bacterial or fungal origin attack the structural integrity of host tissues, whereas toxins act in a more subtle manner. Permeability is increased by non-specific toxins like lycomarasmin, fusaric acid, alternaric acid, picolinic acid, etc. Lycomarasmin and fusaric acid also interfere with iron distribution in plant tissues by their chelating ability. Specific toxins like victorin not only bring about changes in permeability in the susceptible oat variety but also increase host tissue respiration. This increased tissue respiration does not seem to be brought about by victorin itself. It has been suggested that salts or other materials leaking from the vacuole and coming in contact with mitochondria might increase respiration, particularly as victorin has no direct effect on the mitochondria. Victorin added to isolated mitochondria does not affect the release of electrolytes or oxidative phosphorylation. Thus, the toxin produces indirect effects on mitochondrial activity but the relation of these effects to tissue respiration remains to be determined.

In soil-borne pathogenic wilt of cotton, ionic imbalance results in an accumulation of divalent cations like Ca and Mg and a marked diminution of K and Fe in leaves. It is difficult to visualize how pectic enzymes alone can act as protoplasmic poison; indeed, it may make plant cells more susceptible to toxins and toxic metabolites.

Hyperauxiny and the appearance of substances like gibberellins and kinins have been demonstrated in diseased tissues. These substances affect permeability indirectly through their influence on cell metabolism. Alterations in respiration during pathogenesis is the result of changes in membrane function brought about in the wake of interference in water uptake.

In recent years seed exudation and its influence on pre-emergence diseases has been a subject of intensive study. In fact, exudation from seeds vary from variety to variety and provides fungi with nutritive substances necessary for germination and growth and, therefore, seems to hold the key to fungal pathogenesis and consequent ionic imbalance, respiratory changes and a whole host of events that follow.

The Genetic Betterment of Yield and Quality in Food Crops

M. S. SWAMINATHAN
Indian Agricultural Research Institute, New Delhi

Three of the major problems now under intensive genetic investigation are: tailoring new strains of plants to the needs of dry farming, improving the efficiency of utilization of nutrients by crops in irrigated areas and the upgrading of the quality of food grains from the nutritional and industrial standpoints. The following are some of the genetic tools employed in these studies.

Breeding Varieties for Better Performance under Conditions of Moisture Stress

A clear understanding of the physiology of growth and development of plants in areas characterised by chronic moisture deficit is essential for understanding selection indices in a breeding programme. Earliness and a photoinsensitive nature are desirable attributes in varieties bred for dry areas, since these traits will enable the plant to withstand better the vagaries of the weather. Crossing strains with very divergent maturity characteristics helps to generate abundant genetic variability upon which disruptive selection can be practised. In plants like *Sorghum vulgare* and *Pennisetum typhoides*, hybridity together with earliness confers greater stability in performance. Hence the development of suitable hybrids could help to offset to some extent the effects of an adverse environment. The *Sorghum* hybrid, C.S.H. 1, is an example of the utility of exploiting the advantage genetic heterozygosity provides in dry areas. Seeds of hybrids, however, would be more expensive and the discovery of Dr. N. Ganga Prasad Rao of I.A.R.I., of genetic apospory in *Sorghum vulgare* would, if exploited properly, provide a method of maintaining heterozygosity in a permanent manner and would render the purchase of F_1 seeds every season unnecessary.

The presence of reducing conditions in the soil while being important for the availability of Fe and Mn to the rice plants, creates problems of toxin accumulation. In the development of rice varieties for upland conditions it is important to get the character of rapid senescence of leaves incorporated, since this will reduce both oxygen transport to the rhizosphere and loss of energy through respiration particularly during grain development. The tiller number should be less but the grain number per panicle and grain weight should be high. Also, the root system should be well developed. These indices of selection are now being employed at the I.A.R.I., in the breeding of superior rice varieties for areas where it is not possible to keep standing water all the time. In wheat, the indices of selection for unirrigated conditions are better understood, thanks to the work of Dr. R. D. Asana and his colleagues. Strains with 1 or 2 tillers having ears characterised by branching and with over 50 spikelets per spike are now under development.

Increasing the Efficiency of Utilisation of Nutrients by Crops Grown with Irrigation

Studies by Dr. B. Ramamoorthy at the I.A.R.I. have shown that about 15 Kg. and 25 Kg. of nitrogen have to be applied to get an yield of 1 tonne of rice and wheat respectively. The introduction of dwarfing genes has helped in evolving a plant architecture best suited to the needs of better nutrient utilisation in rice, wheat, *Sorghum* and Pearl Millet. Forced recombination among distinct genotypes, the examination of numerous biparental progenies, the screening of large F_2 and F_3 populations so as to enlarge the recombination spectrum and the introduction of agronomic differential in the selection programme have all helped in the selection of genotypes with the ability of utilising solar energy as well as soil nutrients better. The availability of elegant techniques for the artificial transmutation of genes has facilitated the creation of variability for characters which represent new parameters of human selection, such as productivity per day, fertilizer response, photoinsensitivity, suitability for mechanical harvesting and processing and quality characteristics. Thus, in castor a mutant has been isolated by

Dr. Kulkarni of I.A.R.I. in the progenies of the variety HC 6 irradiated with thermal neutrons, which takes only 120 days from sowing to harvest in contrast to the over 240 days taken by the parent.

Genetic Betterment of Protein Quality

Research in this field started with the studies of Mertz, Bates and Nelson[1] whose examination of isogenic lines of maize differing only at the opaque 2 locus showed that the endosperm of opaque 2 maize contained twice as much lysine and tryptophan, 50% more arginine, asparatic acid and glycine and 30% less alanine and leucine. The cause of these changes is a marked reduction in the level of zein and an increase in the level of glutelin in the opaque 2 maize endosperm. When used in the human diet as the sole source of protein, the value of the mutant approaches that of skim-milk.[2] The prolamine fraction of protein which contains a low lysine content is 3% in rice, 12% in oats, 45% in bread wheat (*Triticum æstivum*) 60% in *durum* wheat (*T. durum*), 50% in maize and 60% in *Sorghum*. Genes for the suppression of prolamine synthesis will help to enhance the content of lysine content in many cereals. However, the percentage of lysine in the prolamine and glutelin fractions varies in different plants. Thus, wheat gliadin contains 0·85% lysine in contrast to 1·3% lysine in the glutelin fraction.[3] On the other hand, in *Sorghum* the prolamine contains less than 0·2% lysine while the glutelin moiety contains 2·5 to 3% lysine. Hence prolamine-suppressor genes will be useful only in plants like maize and *Sorghum* where the lysine content is low in the prolamine moiety. Research on exploiting both naturally occurring and induced variability for amino-acid balance in the major cereals, millets and pulses is currently underway at I.A.R.I. and the Nutrition Research Laboratory, Hyderabad. Such research is of immense significance since over 66% of the protein supply in an Indian diet is contributed by cereals.

The physical properties of protein like toughness and elasticity are very important in wheat. A strong gluten is essential for bread making while a weak one is excellent for making biscuits. Grains with a strong gluten identified by a high Pelshenke value, also suffer less from weevil infestation during storage. The Food Industry should become variety-conscious since it is possible now to match varieties to end-use. The data already available indicate an immense scope for the genetic upgrading of both the quantity and quality of proteins in the major food crops.

Meteorites as Probes for Studying the Archaeology of Cosmic Rays

D. LAL
Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Bombay-5

Two types of nuclear phenomena occur in meteorites during their interplanetary travel: (1) nuclear interactions of primary and secondary particles of cosmic radiation (solar and galactic) and (2) solid state damage due to galactic multiply charged cosmic ray nuclei. The former results in an appreciable change in the composition of the meteorite which depends on the irradiation age of the meteorite, flux of cosmic rays during the irradiation period and depth within the meteorite. In the case of the latter, the effects are important only for nuclei of $Z > 22$, since only these particles have high enough ionisation losses to produce a significant solid state damage. A corollary to this statement is that the depth variation in the solid state damage would be considerably larger than for other nuclear processes, *e.g.*, the rate of nuclear spallation within the meteorite.

Based on recent extensive study of the two nuclear processes discussed above, it has now become possible, to study the nature and flux of prehistoric cosmic radiation, in addition to deducing the irradiation history and atmospheric ablation of meteorites. The information derives so far pertaining to archæological data on cosmic rays and meteorites was reviewed briefly.

A Line of Development in the Chemistry of Natural Products

T. R. SESHADRI
University of Delhi, Delhi-7

The use of cardiac drugs for regulating the functioning of the heart was known fairly early in history. But in modern science the study began with William Withering who in 1775 established the use of the leaves of the Foxglove (*Digitalis purpurea*) in the treatment of dropsy. Chemical study revealed the presence of a number of complex glycosides; the most important is digitoxin with gitoxin occupying the second place. In modern medicine the pure glycosides are used in preference to the crude drug or tinctures thereof.

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[1] Mertz, E. T., Bates, L. S. and Nelson, O. E., *Science*, 1964, **145**, 279.

[2] Bressani, R., *Proc. High Lysine Conf.*, Corn Industries Res. Fdn., Washington, 1966, p. 34.

[3] Concon, J. M., Murphy, J. L. and Mertz, E. T., Unpublished data.

A major advance was made by Stoll in the thirties of this century. He used *Digitalis lanata* as a better source and developed improved methods for isolating and using the genuine cardiac glycosides of the leaves. They are called Lanatosides A, B and C. Of these the last has assumed considerable importance as also its derivative called digoxin. The lanatosides undergo partial conversion into other simpler glycosides during extraction unless special care is taken.

Squill (common name: Sea onion) was in medical use in Egypt as early as 1,500 B.C. We now know that its therapeutic properties are due to its content of cardiac glycosides The genuine glycosides of squill called Scillarens were also isolated and studied by Stoll.

Among the richest sources of cardiac glycosides are plants of the family Apocynaceæ, particularly the seeds of the genus *Strophanthus.* The seeds of *Strophanthus Kombe,* a vine growing in the tropical forests of Africa and Strophanthin, a pure substance isolated from it, were introduced into medicine by Sir Thomas Fraser in 1890. The chemical investigations were made mainly by Jacobs.

Shortage of imported materials during the last World War emphasised the urgent need in India to develop the country's own resources. Among drugs the cardiac glycosides were specially important. A continued study of Indian cardiac drugs by Rangaswami and co-workers has yielded highly fruitful results.

Digitalis purpurea and *D. lanata* which were introduced into India recently are now grown in limited areas in Kashmir and Kerala. Varieties of Squill are widely distributed in our country and can be used to provide drugs and rodenticides. From commercially available dry squill slices, a convenient large-scale method has been developed and standardised to yield pure scillaren A; the earlier process based on fresh squill was inconvenient. Strophanthus is of very limited availability in India. *S. wightianus* which grows sparsely in Kerala has been shown to contain the rare glycosides called divaricoside and caudoside. *Cerbera odollam* another Apocyanaceæ tree grows wild along the back-waters of Kerala. Its seed kernel has been found to contain toxic glycosides more or less similar to those present in *Tevetia neriifolia* described later.

Plants commonly called oleanders (family: Apocynaceæ) contain cardiac glycosides in all their parts, root, bark, leaves, flowers and seeds. *Nerium odorum* (*N. indicum*), the sweet scented oleander, contains, particularly in its bark, a number of closed related cardiac glycosides called odorosides A, B, C, D, E, F, G, H, I, J, K, L and M. Much work has been done on this by the Reichstein school at the University of Basel, in which Rangaswami took a prominent part. This oleander has been used as a drug in ancient Indian medicine, but Western medicine has taken little note of it as a drug and hence it is not used by the allopathic medical practitioners in India. Recently preparations from this plant are finding special uses in Russia and this has led to a revival of interest in our country also.

The yellow oleander (*Thevetia neriifolia*) seeds have been known to be highly toxic and dangerous. This is largely due to the glycoside called thevetin. A more careful study of the components and their chemistry has led to the production of a new glycoside called peruvoside whose properties are unique; it is highly active as a cardiac drug and is remarkably free from disabilities and side effects. This has been established by numerous clinical trials. It is therefore considered to be one of the most useful of drugs available for the treatment of cardiac insufficiently. Further, the raw material is readily available in unlimited quantities in our country. The discovery is therefore of great national importance, and it refers to a field in which synthetics have not displaced natural products.

Meteorological Instrumentation for Atmospheric Studies

Miss Anna Mani
Director (Instruments), India Meteorological Department, Poona-5

The contributions made in India to the growth of the science of meteorological measurements, the instruments developed and used during the last decade for the study of the atmosphere and the main results of these investigations are described.

While there has been naturally little or no change in the instruments used for climatological observations, in synoptic measurements for immediate application to short-term weather and flood forecasting and for æronautical meteorological purposes, there have been significant developments.

Among the new instruments developed for use at international airports is a current weather instrument system with electrical and electromechanical sensors, which transmit over cables meteorological information from areas of interest to the pilot to the traffic control and meteorological briefing offices, where they are continuously recorded. An UHF radio link which would signal the information on command or at specified intervals has also been devised.

The current weather instrument system becomes an unmanned automatic weather station, when all the cables are replaced by radio links and an idependent power supply is provided. Installed in normally inaccessible areas on land or sea, they are capable of sending regularly over radio weather information of vital importance in weather analysis and forecasting.

A specialized version is a radio reporting rain and river gauge system which measures and transmits over radio rainfall and river gauging information from river catchment areas, fundamental in flood control and forecasting. The transmitter station with its measuring, counting, coding and programming units, housed in a water-proof cabin, has a range of 100 km., which can be extended by the use of simple radio relay stations. The unit has been field tested successfully in the Koyna catchment area for a year and near Poona for many years.

It is in the field of physical research that the greatest advances have been made. A whole family of instruments has been evolved and constructed, for measuring the various short and long wave components of the radiation balance of the earth and the atmosphere. Direct solar radiation, global radiation of the sun and sky, diffuse radiation from the sky, albedo, effective outgoing radiation and net radiation are measured at a network of 24 stations in India. The vertical distribution of the infrared radiative flux in the atmosphere is measured with balloon borne radiometer sondes. These measurements have resulted in the evolution of a radiation climatology for India and its neighbourhood.

Radiation measurements fall into two classes, those which determine the thermodynamic conditions of the atmosphere and those where radiation is used as a probe to investigate the structure of the atmosphere. The depletion of the downward beam of radiation has proved an invaluable probe in the study of the upper air. Valuable information on the dust content of the troposphere and stratosphere have been obtained by a study of the intensity of solar radiation in various selected spectral regions. Systematic measurements at a number of stations have established an ærosol climatology for India and also shown that normal concepts regarding atmosphere turbidity parameters have to be radically altered to fit in with Indian observations.

Atmospheric ozone is a very important parameter in the study of the fundamental physical processes affecting the energetics and motions of the atmosphere. An electrochemical ozonesonde to measure the vertical distribution of ozone in the atmosphere has been developed at Poona and flown from a number of stations in India. Ozone exists in relatively small concentrations throughout the troposhere, the concentration increasing markedly with height in the lower stratosphere, reaching a maximum at about 25-28 km. Latitudinal and seasonal variations of ozone have been studied. The equatorial atmosphere is the principal region of ozone production and information on the formation and transport of this atmospheric tracer, a quasi-conservative property below 20-25 km., is of great importance in understanding the physics and dynamics of the atmosphere.

Measurements of atmospheric electricity—the electric field, the electrical conductivity of the air and the air-earth current—are also important, providing as they do a valuable index of the time variations of global electrical activity. Measurements of these parameters have been made at Poona both at the surface and in the free atmosphere using electrographs and balloon borne electrosondes developed at Poona.

The Basic Causes of Large-Scale Deficiency of Southwest Monsoon Rainfall Over India in 1965 and 1966

C. Ramaswamy
Council of Scientific and Industrial Research, C/o. The Observatory, Lodi Road, New Delhi-3

The southwest monsoon caused very deficient rainfall over extensive areas of the Indian subcontinent in two successive years, 1965 and 1966.

On the basis of northern hemispheric data upto the 100 mb. (approximately 16 km.) level, a detailed analysis has been made of the weather situations which led to these large-scale rainfall deficiencies. The following are the tentative conclusions drawn from the analysis :

(*i*) In June, 1965, taken as a whole, the meandering upper westerlies dominated the circulation, "forcing" the high-level easterly circulation over the monsoon area to regions south of latitude 15° N. Consequently, the onward march of the monsoon into northern India west of 88° E. was considerably retarded.

(*ii*) In some months, the monsoon depressions did not develop at all. In some other months, they developed over unusual places. One of these depressions was very short-lived while the others had very abnormal tracks.

(*iii*) Instability in the middle-latitude westerlies during the mid-monsoon months led to highly cellular flow patterns to the north of the Himalayas and extension of large amplitude slow-moving troughs from the higher latitudes into India at the 500 mb. (6 km.) level and the development of "cut-off" cyclonic vertices even over the Indian region at the 500 mb. level. This resulted in weak monsoon over the major part of the country.

(*iv*) The performance of the monsoon in the interior of the country *after the monsoon established itself*, did not seem to depend upon the actual moisture content of the monsoon air but on the mechanism available to lift the monsoon air to precipitate its moisture.

This study has revealed that the more important basic causes of large-scale deficiency of monsoon rainfall have to be sought for in the high-level westerlies and easterlies and in the perturbations associated with the easterlies in relation to sea-level systems including those moving westwards from the southwest Pacific and the China Sea.

High Pressure Phenomena in Solids

A. JAYARAMAN
Bell Telephone Laboratories, Murray Hill, N.J.

Electronic first order phase transitions, metal-semiconductor or semimetal transitions and conduction band crossover in semiconductors are observed at high pressures. In metallic cerium the *4f* electron is promoted to *5d* and in cesium the *6s* electron collapses to the *5d* state.

In cerium the phase boundary involving the *4f-5d* transition terminates near 600° K. and 18 kbar pressure. Discontinuities in the first order thermodynamic quantities as well the abrupt decrease in resistivity associated with the transition progressively diminish in magnitude. The resistance *vs.* pressure isotherms clearly demonstrate the critical termination of the phase boundary and are very much reminescent of P-V isotherms of liquid-vapour systems, above and below the critical temperature. The fusion curve exhibits a broad minimum and this is related to the anomalous compressibility of fcc Ce in the super-critical region due to a continuous *4f-5d* electron promotion.

In cesium, the electronic transition not only takes place in the solid state but also in the liquid. The fusion curve maximum associated with the fcc phase indicates that a continuous electron collapse must be taking place in the liquid over a broad pressure range. Without a mechanism of this sort it is hard to reconcile the density increase upon melting, since a liquid can never be denser relative to an fcc solid. Pressure *vs.* resistance results on liquid Cs offer substantial support to the collapsing model of the liquid under pressure.

Divalent fcc metals such as ytterbium, strontium and calcium undergo metal-semi-conductor or semi-metal transition at high pressure, due to the changes in the band overlap. In Yb an energy gap appears at about 15 kbar and this increases at a rate of 5 mV/kbar up to 35 kbar. In strontium and calcium the band overlap does not completely vanish but the conductivity substantially decreases due to the change in density of carriers, as the amount of overlap decreases. This behavior is characteristic of a semi-metal.

In germanium and germanium family semiconductors three types of conduction band minima occur; at the B.Z. centre (Γ), along the [111] directions (L) and near [100] directions (X or Δ) in k space. Since the pressure coefficients of the former two are large and positive and the latter negative, pressure causes conduction band crossover and profoundly influences the transport properties. By studying the pressure variation of these properties it is possible to reconstruct the conduction band structure and obtain information on electron mobilities associated with them. Pressure experiments to nearly 50 kbar hydrostatic pressure on Ge, GaSb and GaAs have established that such crossovers occur and that these semiconductors become silicon like at high pressures.

Finally, pressure experiments have been crucial in establishing the basic mechanism involved in Gunn effect, namely, the interband, transfer of hot-electrons. In n-GaAs where the effect is seen strikingly, the threshold voltage for Gunn oscillations decreases with increasing pressure and the effect disappears when more than half the carriers are in the upper conduction band minima.

Charge Transfer Spectra and Organic Semiconductors

C. N. R. Rao
Department of Chemistry, Indian Institute of Technology, Kanpur

General features of the electronic and vibrational spectra of charge transfer complexes will be described in the light of Mulliken's theory. Various donor-acceptor systems which give rise to c.t. transitions will be classified. Charge transfer processes are of importance in the understanding of reaction mechanisms, iondipole and dipole-dipole interactions. Charge transfer complexes show interesting semiconducting properties, particularly when radical ions are present in the system. Studies on such organic semiconductors employing electrical and spectroscopic techniques will be presented.

Optical Properties of Cholesteric Liquid Crystals

S. Chandrasekhar
Department of Physics, University of Mysore, Mysore

A theory of the very high rotatory power exhibited by cholesteric liquid crystals has been developed by the use of the Jones calculus for optical systems.[1] The calculations are based on a model in which the liquid crystal is regarded as built up of a large number of thin birefringent layers arranged helically. When light is incident normal to the layers, *i.e.*, along the screw axis, selective reflection of one of the circularly polarized components takes place and the rotatory dispersion in the neighbourhood of the region of reflection is anomalous. The reflection curve and the amplitude attenuation factor, $\exp(-\xi)$, for circularly polarized light at normal incidence are derived as functions of wavelength by setting up difference equations closely similar to those formulated by Darwin in his dynamical theory of X-ray diffraction. Within the range of total reflection, ξ is real, primary extinction occurs and the medium is highly circularly dichroic. The spectral width of the reflection and the primary extinction coefficient predicted by theory compare favourably with the experimental values. Outside the region of total reflection, ξ is imaginary and opposite in sign on opposite sides of the reflected band. This is responsible for the reversal of the sign of the rotation on crossing the band. The theoretical relationship between reflection, circular dichroism and anomalous rotatory dispersion is in general agreement with the experimental curves of Fergason.[2] The phenomenon brings out clearly certain aspects of the dynamical theory which are not so easily demonstrable in the X-ray case. For example, the circular dichroism in the totally reflecting range is a striking proof of the effect of primary extinction, and similarly, the anomalous rotatory power is direct evidence of the variation of the phase of the primary wave in the region of multiple reflections.

Further confirmation of the model is obtained from recent observations in Bell Telephone Laboratories[3] of diffraction effects when light is incident normal to the screw axis. A mathematical treatment of the problem has been given[4] by applying the Raman-Nath theory of the diffraction of light by ultrasonic waves. The diffraction is a consequence of the fact that when the electric vector is polarized perpendicular to the optic axis, there exists a periodic variation of the refractive index in the helical structure of the liquid crystal. The emergent wavefront is therefore corrugated. Intensities of the first few orders of diffraction maxima have been caluclated for some typical values of the parameters involved.

Study of Plasma Noise in the Lower Ionosphere Using Rocket Borne Langmuir Probe and Plasma Noise Probe

Satya Prakash
Physical Research Laboratory, Ahmedabad

Rocket borne Langmuir probes developed at Physical Research Laboratory have been used to determine the electron densities and temperatures in the lower ionosphere. A plasma noise probe which determines the fluctuations in the Langmuir probe current in the frequency range 50 Hz to 1000 Hz has also been developed and successfully used along with the Langmuir probes. The frequency range can be extended if necessary. The system is briefly described here.

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[2] Fergason, J. L., *Liquid Crystals*, Edited by Brown, G. H., Dienes, G. I. and Labes, M. M., Gordon and Breach, London 1966 p 89.

[3] Sackmann E., Meiboom, S., Snyder, I. C., Meixner, A. E. and Dietz, R. E., *J. Am. Chem. Soc.*, 1968, **90**, 3567.

[4] Chandrasekhar, S. and Shashidhara Prasad, J., To be published in *Dr. Bhagavantam's 61st Birthday Volume*, Academic Press, London and New York.

The observed fluctuations represent fluctuations in the electron and ion density in the ambient medium and are called 'plasma noise'. These fluctuations are believed to be genuine in most of the height regions where they occur. The salient features of the observed fluctuations are described. It is found that plasma noise occurs in several distinct height regions in the lower ionosphere. The features of the noise in the different regions are different. It is found that the noise is in general of two types. One type occurs randomly with different frequency range and bandwidth and is localised in nature. The other is of continuous type and usually has a wide band spectrum.

Forces which can produce these fluctuations can be either mechanical or electrostatic in nature. Winds and turbulence in the neutral medium, electric fields and plasma turbulence are some of the agencies giving rise to the observed noise. Neutral turbulence and plasma turbulence can give rise to the localised fluctuations observed. Electric fields and winds occur over much larger spacial extents (horizontally and vertically) and therefore can be the cause of the observed continuous noise, probably through instabilities.

The plasma in the E region of the ionosphere is unique in that, while the collision frequency of the electrons is less than their gyrofrequency, for the ions the collision frequency is greater than the gyrofrequency. Theories of plasma instabilities in collisionless plasmas are therefore not fully applicable in this region.

It is expected that the information obtained from ionospheric plasma probes will not only prove to be valuable for developing an appropriate theory for plasma instabilities in the ionosphere, but also be of help in studying the nature of the forces prevalent there.

Crustacean Physiology in Relation to Prawn Culture

N. Kesava Panikkar

National Institute of Oceanography, Rafi Marg, New Delhi

The Crustacea are principally aquatic organisms sharing many physiological features with the rest of the Anthropoda. They, however, show certain distinct physiological features in their relationship with the environment. The large majority of them are marine but certain groups have penetrated into brackish and freshwaters while a small number of species have become established on land. The special features in their physiology are: (*i*) moulting and absorption of water as an essential feature during growth, (*ii*) adjustable respiratory metabolism, (*iii*) highly developed powers of osmoregulation, (*iv*) feeding processes dependent on availability of detritus and smaller organisms, and (*v*) metabolic adjustment in relation to temperature. Recent work has also shown endocrine control which extends to certain aspects of physiological function.

A group of crustaceans which have become important from many points of view at the present time are the prawns, because of their high commercial value and possibility of increasing yields through cultural practices. The paper discusses those aspects of physiology which have a bearing on cultural practices for prawns with a view to increase the yield from this unique aquatic resource.

Chief Factors which Control Activity of the Southwest Monsoon Over the Indian Sub-continent

B. N. Desai

173, Swami Vivekananda Road, Vile Parle, Bombay-56

The factors considered to be most important for the activity of the Southwest monsoon are the following: (*i*) Location of the heat-low over West Pakistan due to the presence of the Western Himalayas and mountains on the northwest frontier, (*ii*) the drawing northwards of the southwesterly to westerly air of oceanic origin which leads to the development of the trough of low pressure over the Gangetic Valley under the influence of the Western Ghats on the air motion and northwestwards deflection of the moist current by the Burma coast mountains and the Eastern Himalayas. The topographical features of the Indian subcontinent contribute significantly in making the monsoon circulation self-sustaining in the lower levels of the atmosphere. The westerly jet which is to the north of about 40° N. between about 70° E. and 100° E. is not a part of the monsoon circulation.

The intensity of the heat-low and the trough of low pressure and the strength of the moist current are affected considerably by the (*a*) troughs in the westerlies which move eastwards across the Western Himalayas and (*b*) low pressure waves which move eastwards across Burma south of about 25° N. In addition one has to consider developments over Africa which might inject cyclonic verticity into the monsoon current over the Arabian Sea.

The activity of the trough of low pressure just south of the equator between about 60° E. and 110° E. and the location and orientation of the high pressure cells in the South Indian Ocean which are affected by the movement of troughs in the middle latitudes of the southern hemisphere, are also important for strengthening of the moist southwesterly to westerly current over the Arabian Sea and the Bay of Bengal.

The influence of the easterly jet over the activity of the monsoon is not quite clear.

Adaptation and Gene Erosion in Some Crop Plants

B. R. Murty
Project Co-ordinator (Millets), Division of Genetics, Indian Agricultural Research Institute, New Delhi

The nature of adaptation of living systems to specific environments and their capacity for wider adaptation are genetically controlled and are important in crop improvement. The adaptation of crop plants is the response of these organisms to man-made environments which may not be those existing in nature. The limits of adaptation are not explored and some of the assumptions that high adaptability is incompatible with high performance do not appear to be justified from the data on world collections. Statistical measures of adaptation over several environments in biologically meaningful terms have been developed and have been utilised to evaluate the world collections of cereals including millets and wheat. The nature of interaction of genotypes with environments determines the breeding procedure to be adopted. The genetic physiological and ecological information in interpreting the nature of adaptation and to construct levels of adaptability and to classify the zones into local environments is illustrated. A similar analysis of the improved strains in the All-India Co-ordinated crop improvement programmes has revealed the stability of some specific genotypes such as hybrids in Sorghum and Pennisetum and some Indica rices. The implications of these stability parameters is discussed. The major components of adaptation from the available data appear to be photo-insensitivity, early vigour, synchronous development of tillers, dwarf habit and capacity for rapid transfer energy from leaf to grain. Selection for such traits has already permitted the development of varieties of wheat which are adapted to both rainfed and irrigated areas. The effect of high local adaptation would be adverse with the genetic erosion of alleles for productivity, results in instability under changed environments, and narrows the variation available for selection. Example of such erosion in millet, rice, wheat, cotton and pulses are found for alleles for maturity, tillering, competitive ability, grain size and grain quality and are illustrated. Among the other adverse effects of local adaptation are the loss of genetic variation for important characters influencing productivity such as photosynthetic capacity and synchrony of tillering in Pennisetums of Nigeria and rapidity of germination in some cereals and some quality characters not selected for in rice, wheat and sorghum. The cases where some genes controlling the characteristics of significance under domestication but have little or no survival value in nature are large in several crop plants. An analysis of the mechanisms of adaptation in these crops from experimental data is illustrated. The need for conserving the array of genotypes with adaptive gene blocks, studying the frequencies of isozymes in related but adaptively different populations, selection for components of wide adaptation in early generations and prevention of genetic erosion of useful alleles in low frequencies in the populations is stressed.

X-Ray Flux from Celestial Sources

U. R. Rao, E. V. Chitnis, A. S. Prakasa Rao and U. B. Jayanti
Physical Research Laboratory, Ahmedabad

Two rocket-borne X-ray payloads were successfully launched from the Thumba Equatorial Rocket Launching Station on 3rd and 7th November, 1968 respectively. The detector consisted of a proportional counter filled with Xenon and Methane at atmospheric pressure. A mechanical collimator defined the angle of resolution of the detector.

The detector with its axis mounted perpendicular to the spin axis of the rocket scanned the horizon as the rocket spun. The rockets were launched when the Sco-X-1, Tau-X-1 and Centaurus X-2 sources were just visible on the horizon. The entire detector system was calibrated with the Fe^{55} radioactive source attached to the nosecone to an altitude of 60 Km. at which height the nosecone was ejected. The results on the X-ray flux and the energy spectrum of these sources are presented.

LETTERS TO THE EDITOR

ANGULAR CORRELATION STUDY ON THE 223-161 keV CASCADE IN Cs^{133}

ANGULAR correlation studies were carried out on the 223–161 keV gamma-gamma cascade in Cs^{133}, as these studies are expected to yield information on the spin of the 384 keV state. The possibilities of 3/2 + and 5/2 + characters for the 384 keV state in Cs^{133} are discussed by Hennecke *et al.*[1] who assigned the mixing parameter of the 223 keV transition to be $|\delta| = 0\cdot40$.

Conventional methods of angular correlations are unsuitable for this measurement in view of the small intensities involved. The present work on angular correlations was carried out in the sum-peak coincidence mode[2] using a fast-slow type of arrangement[3] with a 100-channel analyser. The 100 keV bias sum-peak coincidence spectrum showed peaks at 384 and 437 keV which are well separated, all other two-gamma cascade sums being suppressed by the bias condition. The peak at 384 keV (corresponding to 223 + 161 keV) is employed for the present angular correlations. The spectra recorded for angles 180°, 135° and 90° between the detectors are employed to fit the angular distribution to the standard polynomial and obtain the correlation coefficients A_2 and A_4, using White's[4] method. The resultant values, corrected by Frankel's[5] method, are given by $A_2 = +0\cdot62 \pm 0\cdot10$ and $A_4 = +0\cdot02 \pm 0\cdot04$.

A large value of asymmetry is definitely established although the intensities are small as a consequence of the use of the sum-peak coincidence technique. The theoretical values of the correlation coefficients (A_2) are estimated for possible spin values of 3/2 + and 5/2 + for the 384 keV state and assuming the 161 keV state has a character of 5/2 +. The 161 keV transition is assumed[1] to be M1 + E2 with a mixing ratio of 0·61 and the values of A_2 corresponding to $\delta = 0\cdot4$ for the 223 keV transition are obtained for both signs of δ. The values are given in Table I.

The value and sign of A_2 obtained in the present experiment support a spin assignment of 3/2 for the 384 keV state. The 223 kev transition has a mixing parameter with negative phase.

TABLE I
Theoretical values of the correlation coefficients for the 223-161 keV cascade

Sl. No.	Spin Sequence	Values of A_2	
	384–161–0 keV States	$\delta = 0\cdot4$	$\delta = -0\cdot4$
1	$3/2^+ \rightarrow 5/2^+ \rightarrow 7/2^+$	$-0\cdot28$	$+0\cdot75$
2	$5/2^+ \rightarrow 5/2^+ \rightarrow 7/2^+$	$+0\cdot006$	$-0\cdot55$

Laboratories for Nuclear Research,
Andhra University,
Waltair, *September* 25, 1968.

P. BRAHMANANDA RAO.
V. LAKSHMINARAYANA.

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THE TEMPERATURE DEPENDENCE OF NUCLEAR QUADRUPOLE RESONANCE IN CYANURYL CHLORIDE

THE N.Q.R. frequencies in cyanuryl chloride ($C_3N_3Cl_3$), their Zeeman effect and temperature dependence have been studied experimentally by Morino *et al.*[1] It was pointed out by them that the temperature variation conforms qualitatively to Bayer's theory.[2] Results of quantitative calculations to test this agreements are reported here.

The present calculations take into account (1) the finite asymmetry parameter and (2) the difference in torsional frequencies. The prescription suggested by Morino *et al.*, *viz.*, $A_x\phi_x^2 : A_y\phi_y^2 : A_z\phi_z^2 = 1\cdot4 : 2 : 1$ has been used in this calculation. The values of the quadrupole resonance frequency (ν) and asymmetry parameter (η) of the stationary molecule are given in Table I.

TABLE I

Temperature in deg. K.	Observed frequency[1] in Mcps.	Calculated frequency in Mcps.
294	36·2997	36·2995
197	36·5502	36·5718
77	36·7708	36·7109
$\phi_x = 31\cdot1$ cm.$^{-1}$	$\phi_y = 52\cdot6$ cm.$^{-1}$	$\phi_z = 37\cdot2$ cm.$^{-1}$
$\nu = 36\cdot94$ Mcps.	$\nu_0 = 36\cdot83$ Mcps.	$\eta_{294} = 0\cdot23$
$\eta = 0\cdot238$	$\eta_0 = 0\cdot233$	

The agreement between the observed and calculated values is seen to be satisfactory. The slight discrepancy is attributable to (1) the approximation of the temperature independence of the torsional frequencies and (2) the probable existence of a phase transition between 77° K. and 197° K. The estimated values for the torsional frequencies are of the same order of magnitude as those of other heterocyclic carbon compounds.

The author is grateful to Prof. H. N. Bose for his encouragement.

Department of Physics, G. P. Sastry.
I.I.T., Kharagpur,
November 15, 1968.

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NATURE OF SUGARS IN *CASSIA ABSUS* SEED POLYSACCHARIDE

The plant *Cassia absus* (N.O. Leguminosæ) occurs throughout India. The seeds are known for their use in indigenous medicine and are recommended for various eye diseases and skin affections. The endosperm[1] which is 55% of the total seed weight contains mainly a mucilage. The present communication describes the isolation of this mucilage in a pure form, its properties and also the nature of constituent sugars.

Isolation and Purification.—Seedcoats were removed after grinding the seeds and the material was soaked in water till it swelled up completely. Subsequently, it was crushed to a fine mucilagenous mass in a blender. Mucilage was then removed from the fibrous material by passing through muslin cloth. Fine suspended matter and starch granules were then removed by centrifuging in a supercentrifuge at 25,000 r.p.m. On addition of ethanol to the clear solution the desired polysaccharide precipitated out as a coarse powder. The polysaccharide was found to form an insoluble barium complex.[2] Advantage of this complex formation was taken to purify and fractionate the polysaccharide. It yielded two fractions, A (soluble) and B (insoluble) in dilute acetic acid. Inorganic salts were removed from the two fractions with the help of ion exchange resins. Resulting pure polysaccharides were practically ash free and were used as starting material for the following studies.

The polysaccharides did not reduce Fehling's solution. Nitrogen, sulphur, halogens and uronic acid were absent. Their preliminary analysis is as follows:

		A	B
$[\alpha]_D^{20}$		+ 23·8	+ 22·1
Pentosans, per cent			
Pentoses,	„	7·52	4·90
Furfural,	„	3·86	2·56

Nature of Sugars.—In order to ascertain the nature of constituent sugars, the two polysaccharides were separately hydrolyzed with acid. Course of hydrolysis was followed by iodometric titrations of the released monosaccharides. When hydrolysis was complete (10 hr.), the solution was processed to isolate the sugar mixture. On paper chromatography by the descending method using *n*-butanol, acetic acid and water mixture (4 : 1 : 5; upper layer) as the developing solvent and ammoniacal silver nitrate spray reagent, spots corresponding to galactose (strong), mannose (strong) and xylose (faint) were observed. The sugar mixture was resolved into the pure constituents on a cellulose column with *n*-butanol half-saturated with water. Fractions of the eluate containing pure single sugar were mixed and the sugar isolated. Identity of the respective sugars was established by determining their specific rotations and preparing suitable derivatives. The sugars were D-galactose and D-mannose.

In order to determine the ratio of the different constituent sugars in the two polysaccharides, these were hydrolyzed separately with acid in sealed tubes. The resulting sugar mixture was separated into its constituents on large sheet of filter-paper. Sugar containing strips were eluted by Dent's method.[3] The eluted sugars were estimated by oxidising them with periodate[4] and titrating the liberated formic acid with standard alkali. Ratio of mannose, galactose and xylose was 3 : 1 : 0·17 in A and 3 : 1 : 0·13 in B.

Some information about the nature of linkages in the polysaccharides was obtained from their infrared spectra. Absorption bands at 817 and 874 cm.$^{-1}$ were observed which indicate α-linkage in D-galactopyranose and β-linkage in D-mannopyranose units.[5]

The authors express their sincere thanks to Shri S. C. Gupta, Director, for his kind interest in this investigation. One of the authors (V. P. K.) is thankful to the Ministry of Education for a financial grant.

Dept. of Organic Chemistry,
National Sugar Institute,
Kanpur, *July* 17, 1967.

V. P. KAPOOR.
S. MUKHERJEE.

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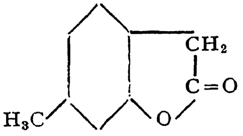
FRIEDEL-CRAFTS CONDENSATION OF THE LACTONE OF 4-METHYL-2-HYDROXY-CYCLOHEXANEACETIC ACID WITH AROMATIC HYDROCARBONS

THE aluminium chloride-catalysed alkylation of aromatics with simple unsubstituted alicyclic lactones has been found to afford a mixture of secondary monoalkylates consisting of the normal and rearranged condensation products of which the former have been successfully converted to polycyclic compounds *via* the polycyclic hydroaromatic ketones.[1] Phillips and Chatterjee[2] studied the Friedel-Crafts condensation of the lactone of trans 2-hydroxy-cyclohexaneacetic acid with a number of hydrocarbons and observed that the alkylation was attended with extensive rearrangement yielding minor amounts of the expected trans 2-arylcyclohexaneacetic acid which could be cyclised to polycyclic ketones and comparative large amounts of the rearranged products consisting of 4-arylcyclohexaneacetic acids together with the 3-aryl isomers, thereby limiting the use of cationic nuclear alkylation in the synthesis of polycyclic compounds. In order to develop it into a useful process for such syntheses *via* cyclic ketones, the lactone of 4-methyl-2-hydroxycyclohexaneacetic acid (I) has been prepared with a view to study the aluminium chloride catalysed alkylation of various aromatics with it.

The Friedel-Crafts condensation of the lactone (I), b.p. 135–140° (8 mm.), n_D^{30} 1·5590, prepared from 4-methylcyclohexane-2-one-1-acetic acid, m.p. 94°, semicarbazone, m.p. 195°, synthesised by an improvement of the method of Kotz and Kayser,[3] with benzene gave a stereoisomeric inseparable mixture of 4-methyl-2-phenylcyclohexaneacetic acid (II; $R=R'=H$) and the 3-phenyl isomer (III; $R=H$) as a colourless thick oil, b.p. 180° (1 mm.), isolated through the ethyl ester, b.p. 140–145° (0·5 mm.) in 50% yield together with 4-methylcyclohexaneactic acid arising *via* hydride transfer with consequent reduction of the lactone. The presence and relative proportion of the components in the mixture was ascertained by the cyclisation of the acidic mixture with polyphosphoric acid when 35% of the material cyclised giving predominately trans 3-methyl-9-keto-1, 2, 3, 4, 9, 10, 11, 12-octahydrophenanthrene (IV; $R=R'=H$), m.p. 145°, semicarbazone, m.p. 170–71°. The structure of the ketone was established by its reduction and dehydrogenation to 3-methyl-phenanthrene, m.p. 63°, picrate, m.p. 138°[4] as well as by an unequivocal synthesis from ethyl 4-methylcyclohexane-2-one-1-acetate and phenyl magnesium bromide by an adaptation of the method of Buchta and Ziener.[5] The condensation led to the formation of the lactone, b.p. 180–185° (1 mm.) which on Clemmensen reduction followed by cyclisation of the acidic material furnished the trans ketone (IV; $R=R'=H$). The identity of the 3-phenyl isomer (III; $R=H$) in the condensation product was established by the dehydrogenation of the acid recovered from the cyclisation experiment to 2, 5-dimethyl biphenyl and its subsequent oxidation by alkaline permanganate to biphenyl-2, 5-dicarboxylic acid, m.p. 278°.[6]

The aluminium chloride-catalysed alkylation of toluene with the lactone (I) in a similar manner afforded a complex mixture of isomeric acids, b.p. 190° (1 mm.), purified through the ethyl ester, b.p. 160° (1 mm.), containing 4-methyl-2-o-tolylcyclohexylacetic acid (II; $R=CH_3$, $R'=H$), 4-methyl-2-*p*-tolylcyclohexylacetic acid (II; $R=H$, $R'=CH_3$) and 4-methyl-3-*p*-tolylcyclohexylacetic acid (III; $R=CH_3$) in 35% yield. A considerable portion of the lactone was reduced, as in the alkylation of benzene, to 4-methylcyclohexylacetic acid. Polyphosphoric acid cyclisation of the acidic mixture resulted in the cyclisation of 33% of the material giving trans 3, 5-dimethyl-9-keto-1, 2, 3, 4, 9, 10, 11, 12-octahydrophenanthrene (IV; $R=CH_3$, $R'=H$), m.p. 142°, DNP derivative, m.p. 252° (25%), and a stereoisomeric mixture consisting predominately of cis 2, 6-dimethyl-10-keto-5, 6, 7, 8, 9, 10, 13, 14-octahydrophenanthrene (IV; $R=H$, $R'=CH_3$), b.p. 168° (1 MM), DNP derivative, m.p. 205° (75%). The structures of the ketones were established by reduction and dehydrogenation to 3, 5-dimethylphenanthrene, m.p. 30°, picrate, m.p. 136°, TNB complex, m.p. 159°, and 2, 6-dimethylphenanthrene, m.p. 33°, picrate, m.p. 136° respectively. Further confirmation regarding the structure of the ketones came from their unequivocal syntheses from ethyl 4-methylcyclohexane-2-one-1-acetate and *o*-tolyl magnesium bromide and *p*-tolyl magnesium bromide respectively through Clemmensen reduction of the resulting lactone followed by cyclisation of the acidic material. An interesting ortho migration of the alkyl group was noticed during selenium dehydrogenation of the hydroaromatic compound derived from the trans ketone (IV; $R=CH_3$, $R'=H$) when 3, 6-dimethylphenanthrene was isolated instead of the expected 3, 5-dimethyl derivative.



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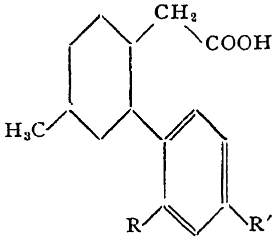

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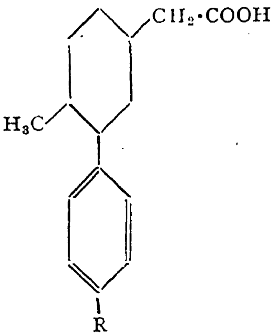

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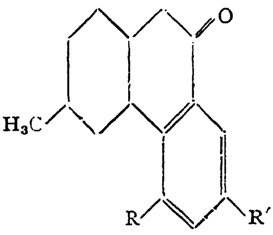

IV

The identity of the 3-aryl isomer (III; $R=CH_3$) in the Friedel-Crafts condensation product was established by dehydrogenation of the acid recovered from the cyclisation experiment to 2, 4′, 5-biphenyl tricarboxylic acid identified as its trimethyl ester, m.p. 103–104°.[2b]

Thanks are due to Prof. S. C. Shome for laboratory facilities and to Dr. P. K. Sen for discussion. A research grant from the C.S.I.R. to one of us (S. P. B.) is gratefully acknowledged.

Dept. of Chemistry, D. N. CHATTERJEE.
Presidency College, S. P. BHATTACHARYYA.
Calcutta-12, *October* 28, 1968.

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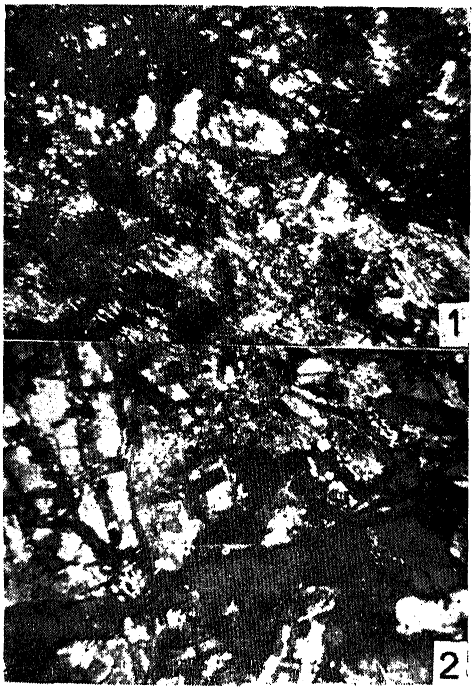
STRATIGRAPHIC SIGNIFICANCE OF META-BASICS IN CHAIL FORMATIONS, SIMLA HILLS, H.P.

THIS short note, records the discovery of a meta-basic body in Chail formations of the Simla Hills. The discovery is of great significance in view of the fact that the absence of meta-basic rocks from Chail formations has been considered as one of the important factors for the classification of older crystalline rocks of the Simla Hills and also in distinguishing between the Jutogh and Chail formations (Pilgrim and West, 1928).

During the recent field trip to the Arki area, Simla Hills, the authors came across lenticular bodies of basic rock in Chail Series, which are represented by sheeny phyllites, near Shekoh (31° 8′ 30″ :: 77° 02′). The strike trend of the formation runs in a NWN-SES direction. The foliation (S_2) shows a dip of 20° to 35° towards ENE. The phyllites are highly folded and the quartz veins showing boudins run parallel to the foliation.

The longer axes of the lensoid masses of the meta-basic rock, now an amphibolite, run parallel to the strike of country rock. This amphibolite represents a basic intrusive sill characterised by swell and pinch structure, which was emplaced prior to the deformation and metamorphism of the country rock (the present sheeny phyllite). The meta-basic sill measures 30 m. in length and 3 to 7 m. in width. On its margins, it shows foliated structure (Fig. 1) whereas the central part is more or less compact and shows sub-blasto-ophitic texture (relict igneous texture; Fig. 2).

On the basis of mineral composition and texture, two types, *viz.*, (1) foliated and (2) non-foliated amphibolites have been recognised. The foliated variety forms the marginal part while the massive one constitutes the core of the sill. Under the microscope, the foliated amphibolite is characterised by rude foliation marked by preferred arrangement of chlorite flakes (Fig. 1). The non-foliated and massive amphibolite shows blasto-ophitic texture (Fig. 2). Plagioclase, hornblende, chlorite and relict augite form the major constituents of the rocks while ilmenite, sphene and hematite are the minor ones. In the foliated variety chlorite is the dominant mineral constituent, whereas, plagioclase and hornblende and pyroxene are the main minerals of the massive variety, the latter assemblage retains the original texture also.



FIGS. 1–2. Fig. 1. Photomicrograph of foliated variety of amphibolite, × 50 cross nicols. Fig. 2. Photomicrograph of an unfoliated variety of amphibolite, × 50 cross nicols.

Pilgrim and West (*op. cit.*, p. 58), while describing hornblende-schists and amphibolites of the Chor area, came to the conclusion that "they are confined in distribution to oldest uppermost rocks, the Jutogh Series...... The main point, however, is that they are never seen cutting underlying Chails or Jaunsar series". From this, it is clear that they considered hornblende-schists and amphibolites as marker for Jutogh Series. Further on p. 131, while concluding the sequence of events in a tabular form, Pilgrim and West (*op. cit.*) have shown that all the igneous activity, intrusion of basic sills, and dykes and olivine dolerites ceased much before the deposition of Chail and Jaunsar formations. Many of the Himalayan geologists have considered the occurrence of meta-basics in older metamorphites in Himalaya as one of the main factors while delineating Jutoghs from Chails.

In the light of the present discovery, the view that igneous activity had ceased to operate after the formation of Jutogh Series, does not hold true. For the relative ages of these two series, the Jutoghs and Chails, factor of absence and presence of intrusives cannot be applied now. Further study about relationship of these two series is in progress.

The authors are thankful to Dr. M. N. Saxena for his valuable suggestions.

Centre of Advanced Study
in Geology,
Panjab University,
Chandigarh-14, *September* 5, 1968.

I. C. Pande.
Ramesh Kumar.

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AGE DETERMINATION OF *OPHICEPHALUS STRIATUS* BLOCH

Age and growth studies have an important place in fishery management problems. Some of these studies based on the presence of annual marks, rings or zones on hard skeletal parts have been made extensively on fishes of temperate waters. The formation of these annual marks or annulations results from the differences in growth of the scales in different seasons. The narrow and broad growth zones as observed on the skeletal parts represent the period of annual slow and fast growth in the year-to-year life-history of the fish. The narrow growth zones, with a few exceptions,[1] are known as winter marks which appear as a result of cessation of growth during the severe winter. In tropical waters, on the other hand, although the demarcation in winter and summer is not as marked as in temperate waters, definite annulations on the scales,[2-3] otoliths, pectoral spines,[4] and opercular bones[3,5] have been reported from time to time.[5] The causes for these zonations in tropical fishes have been repeatedly studied and, so far, no satisfactory explanation has been found, although vague generalizations have been made concerning them, the zonations have been shown to be annual. The present note is based on a study of the scales of *Ophicephalus striatus* at Aligarh, U.P.

Scales from the region between the anterior extremity of the dorsal fin and lateral line were taken out, cleaned and examined under a hand-lens or a binocular microscope. Methods employed were the same as already reported in an earlier paper on *O. punctatus*.[3] Age determination was made on 361 fishes of both sexes combined, ranging from 14 cm. to 56 cm. in total length. The annulations comprised of narrow and broad zones (Fig. 1) similar to that of *O. punctatus*. The criterion of age was based on the presence of the number of narrow zones which represents a period of restricted growth. The maximum number of rings observed on the scales was 5. In all, approximately 5% of cases were found doubtful where the annulations on the scales were not very clear to provide an indication of age.

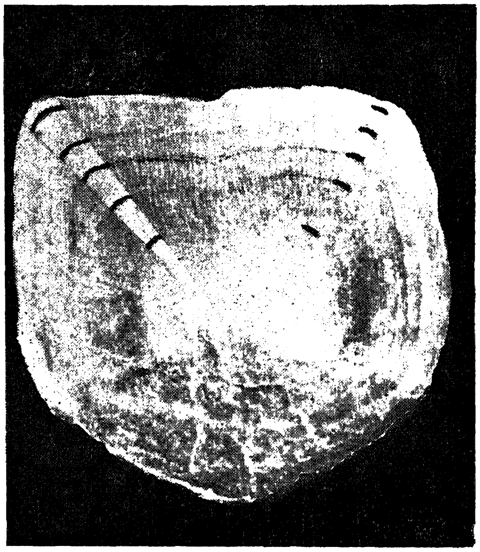

FIG. 1 Scale photograph of *Ophicephalus striatus* showing 5 annulations in the form of 5 narrow dark zones, 56·9 cm. in length.

There appears hardly any reason to doubt the validity of the annulus as true year marks as the data agree well with the arguments for annulus validity presented by Hile.[6]

The number of zones increases with the increase in length of this fish which supports Hile's first argument, "*Increase in number of annuli is generally accompanied by increase in size of fish*".[7]

Further evidence in support of the validity of the annual nature of these zones was obtained on comparing the modes of Peterson's length frequency distribution with the modal length of age group based on scale reading (Fig. 2). It can be observed that the modes of at least first three age groups based on scale reading correspond to the modes of the length frequency distribution. The higher age groups do not fall in agreement with the length frequency histograms because of considerable size overlap. Similar problem of size overlap as given in *O. punctatus* can be applied

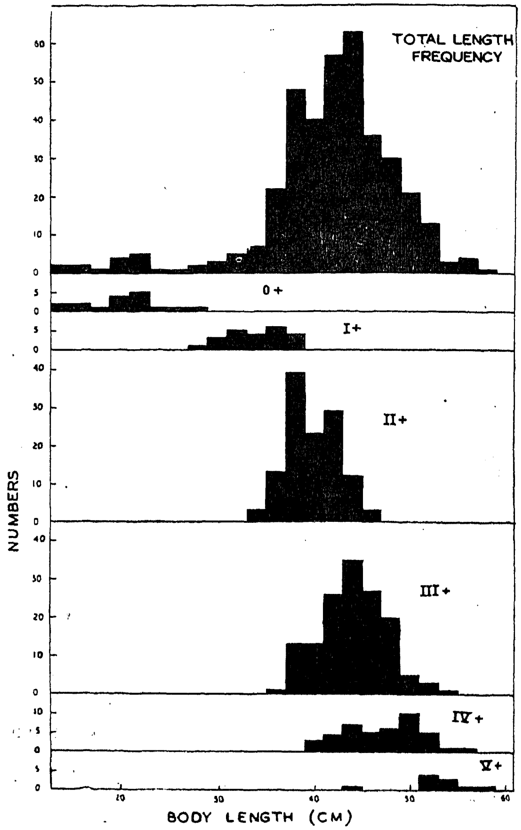

FIG. 2. Dissection of polymodal length frequency histograms of *Ophicephalus striatus* on the basis of scale readings. Top histograms show the total length frequencies. In the other six histograms are shown the various age groups as read out through scales.

to this species as well, because both the species are similar in their breeding habits and fall in the same category.[8] Thus the agreement of length frequency modes with the modes of first two age groups, determined through scales, provides another evidence about the annual nature of these zones in the light of Hile's second argument, "*modes in the length frequency distributions of small fish coincide with modal lengths of age groups based on scale readings*".

An attempt was made to compare the average length of various age groups with the back calculated length obtained through the regression equation $\mathrm{Log}\ L = a + n \log l$ (where L being length of fish and l the lengthwise diameter of the scales). The observed average lengths of fish at various ages agree with the back-calculated length to a considerable degree (Table I). This again supports the validity of the annual nature in the light of the third argument presented by Hile, "*Length at the end of various years of life calculated from scale measurements agree well with the corresponding lengths of younger age groups whose ages were determined by scale examination*".

Table I

Comparison of observed and calculated lengths of various age groups

Age (years)	Mean length observed from scale reading	Back-calculated length
0+	20·9	25·20 (I)
I+	35·1	31·99 (II)
II+	41·1	38·75 (III)
III+	45·1	44·53 (IV)
IV+	48·1	49·36 (V)
V+	53·1	..

In the light of foregoing comments, the growth zones on the scales of *Ophicephalus striatus* can be recognised as annual marks. The observations on the annulations in different seasons can at least throw some light on the period, if not exactly on the causes of the zone formation. Such studies will help to discover the exact causes of the zone formation in tropical fishes.

The author is indebted to Dr. S. Z. Qasim for supervising this work which forms a part of author's thesis for the Doctor of Philosophy in the year 1965 at the Aligarh Musilm University, Aligarh. Thanks are also due to Dr. N. K. Panikkar and Shri R. Jayaraman for critically going through this note and kind encouragement.

National Institute of Oceanography (CSIR),
Rafi Marg, New Delhi,
October 25, 1968.

V. S. Bhatt.

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A NOTE ON AN OUTBREAK OF RABIES IN HORSES

Although sporadic cases of rabies have been reported in equines in India since long, rabies in the form of an outbreak in equines has been reported only recently (Pavri *et al.*[1]). These authors found that almost at monthly intervals four proven cases occurred on a single stud farm near Poona, without any apparent history of bite.

The present report describes an outbreak which occurred in February 1968 at Remount Police Depot, Moradabad, where 45 riding horses were maintained and out of these four animals died within a period of about 10 days.

The authors were deputed to investigate an obscure disease in horses simulating African Horse Sickness. It was reported that inspite of the treatment with broad spectrum antibiotics and sulphonamides one animal had died exhibiting marked rise in temperature, acute respiratory distress and inco-ordination of movements. Since rabies had not been suspected at that stage the tests for detection of rabies were not done.

From the remaining sick animals mare 'Roopkala' was reported to have died that morning after exhibiting the symptoms similar to those described above.

Mare 'Phoolkunwar' was prostrate with high temperature (104° F.), produced gurgling sounds with difficult breathing and struck head constantly against the ground.

Mare 'Savitri' showed nervous symptoms and bit at all objects. The animal was too ferocious to be approached and as such its temperature record could not be kept. She, however, drank Chloral-hydras given in water.

'Roopkala' and 'Phoolkunwar' were also reported to have been treated with broad spectrum antibiotics and sulphas without any success.

On postmortem examination of 'Roopkala' certain lesions simulating those of African Horse Sickness, namely, presence of frothy exudate in the lumen of trachea and bronchi, accumulation of large quantities of straw-coloured fluid in the pericardial sac and thoracic cavity, along with slight hæmorrhages on myocardium, were seen. These lesions simulating African Horse Sickness were probably due in part to the previous vaccination with the live attenuated African Horse Sickness vaccine. On histopathological examination lesions suggestive of viral encephalitis characterised by perivascular cuffing, satellitosis and neuronophagia were observed in the hippocampus.

The blood from 'Phoolkunwar' was examined for the presence of protozoan parasites. No parasites could, however, be detected even on repeated examinations. Unfortunately the postmortem examination of this animal which died the next day could not be done. However, the possibility of rabies being the cause of death cannot be ruled out.

In 'Savitri' which died two days later, on postmortem examination no significant gross lesions were detected but Negri bodies were found in the Purkinje cells of cerebellum.

A 10% antibiotic treated brain suspension of 'Roopkala' and 'Savitri' was each inoculated intracranially into a group of 3 to 4 weeks old Swiss albino mice. These mice died showing typical paralysis of hind quarters and Negri bodies were demonstrated both in the impression smears and in sections. Both these virus isolates were got confirmed by serum neutralization test in mice.

The report is particularly interesting because rabies was confirmed in more than one animal without any history of apparent animal bite. The very similar incubation period is intriguing and cannot be properly explained. The role of mongoose, bats, or other small mammals as the reservoir of the disease is suspected, although no further report of rabies has been received.

The authors wish to thank the Director, Indian Veterinary Research Institute, for providing facilities of work and to the U.P. Police and Animal Husbandry authorities for their courtesy and help.

Indian Veterinary
Research Institute,
Izatnagar (U.P.),
July 16, 1968.

S. Kumar.
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USE OF ADULT MICE FOR POTENCY TESTING OF INACTIVATED TYPE 'O' FOOT AND MOUTH DISEASE VACCINE

Mice have been used for testing the immunogenicity of foot and mouth disease (FMD) vaccine with encouraging results (Gayot *et al.*,[1] Onufriev *et al.*[2,3]). The present report describes the use of adult mice for test of immunogenicity of formalin inactivated, aluminium hydroxide gel adsorbed type 'O' FMD vaccine.

Three batches of vaccine, namely, OIV, OV, OVI produced for field trial of the vaccine and four batches of experimental vaccine, namely, A, B, C and D containing 20, 30, 40 and 50% virus respectively were used. These vaccines were prepared in accordance, with the method recommended by Frederiks.[4] The potency of each of these vaccines was tested in mice. For this purpose, groups of twenty one-month-old Swiss albino mice were vaccinated subcutaneously with 0·75 ml. of various dilutions of the vaccine. During observation period, some mice from each group died non-specifically and were discarded. After 18 days, the mice in each group along with control group of mice was challenged subcutaneously with 10,000 LD50 of type 'O' mouse adapted virus. The deaths due to FMD virus infection were confirmed by complement fixation test. The protection dose 50 (PD50) was calculated by the method of Reed and Muench.[5] The OIV, OV, OVI batches of vaccine were also tested for their immunogenicity by the method recommended by Frederiks[4] in hill cattle whose prevaccination sera were shown to be free of type 'O' antibodies by serum neutralization test in goat kidney monolayer cultures. The results of potency testing of different batches of vaccine by both the methods are presented in Table I.

It is seen from Table I that a definite immune response was elicited by the adult mice. In general, the degree of protection conferred with the more concentrated vaccine was better than that with the dilutions of the vaccine.

TABLE I

Results of potency testing of inactivated foot and mouth disease vaccine in mice and cattle

Test in Mice				Test in Cattle			
				Animals vaccinated		Number showing lesions after challenge	
Batch of vaccine	Dilution of vaccine used	Percentage of mice after surviving challenge	PD 50 ml.	Dose	Number	Primary	Secondary
OIV	PO	33	..	5	6	6	None
	1 : 2	28	..	10	6	6	,,
	1 : 4	23	..	15	6	6	,,
	1 : 8	13	..	..	..	..	..
OV	PO	75	0·37	5	6	5	None
	1 : 2	44	..	10*	6	4	,,
	1 : 4	18	..	15	3	1	,,
	1 : 8	0	..	..	..	..	,..
OVI	PO	62·5	0·35	5	3	3	None
	1 : 2	40·0	..	10*	6	5	,,
	1 : 4	20·0	..	..	..	..	..
	1 : 8	20·0	..	..	..	..	..
A	PO	31	—	—	—	—	—
	1 : 2	21	..	..	..	..	..
	1 : 4	18	..	..	..	..	..
	1 : 8	18	..	..	..	..	..
B	PO	38	—	—	—	—	—
	1 : 2	28	..	..	..	..	..
	1 : 4	20	..	..	..	..	..
	1 : 8	10	..	..	..	..	..
C	PO	57	0·4	—	—	—	—
	1 : 2	29	..	..	..	..	..
	1 : 4	25	..	..	..	..	..
	1 : 8	18	..	..	..	..	..
D	PO	60	0·35	—	—	—	—
	1 : 2	31	..	..	..	..	..
	1 : 4	47	..	..	..	..	..
	1 : 8	23	..	..	..	..	..
Control	..	15	..	Control	6	6	6

* Field dose of vaccine, PO = Pure vaccine, (—) = Test not done.

Also, the degree of immunity developed was seen to increase with the increased amount of virus in the vaccine (batches A to D). The PD50 of the vaccine could be calculated with batches OV, OVI, C and D only, and was almost equal in each case ranging between 0·35 and 0·4 ml. The results of potency testing in cattle showed that all the three batches of vaccine tested were potent. Thus it is seen that batch OIV which passed the test in cattle could not produce sufficient immunity in mice. From the preliminary results it is clear that adult mice can be used for quantitative potency testing of aluminium hydroxide gel adsorbed inactivated type 'O' FMD vaccine. Potency of a number of batches of vaccine will now be compared by quantitative tests, both in cattle and in mice.

Div. of Bacteriol. & Virol.,
Indian Vet. Res. Inst.,
Mukteswar,
February 10, 1968.

F. F. SHEVETSOV.
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A. C. GOEL.
B. S. NEGI.
P. N. KHANNA.

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PREDISPOSITION OF VIRUS-INFECTED PLANTS TO FUNGUS ROOT-DISEASES*

VIRUS infection is known to alter the entire physiological balance of the plant-host.[1,2] Any such change in the metabolism of the plant is bound to alter the quantity and quality of its rhizosphere microflora.[3] Reports suggesting that virus infections of plants may affect the severity of fungus root-diseases[4,5] were confirmed in green-house studies on the effect of combined infection of certain crop plants with selected viruses and root-rot fungi.[6-8] The present investigation was undertaken to study the possible effect of virus-infection on normal rhizosphere mycoflora.

Seedlings of *Crotalaria juncea* L. were raised three in every pot of 500 g. of garden soil. Ten-day-old seedlings were inoculated with southern sannhemp mosaic virus (SSMV) using a standard inoculum prepared by grinding 1 g. of freshly infected leaves with 1 ml. of glass-distilled water in a mortar. Samplings were made of roots of inoculated and uninoculated plants as well as unsown 'control' soil at weekly intervals, for rhizosphere analyses. Dilution plates were poured in replicates of five using Martin's agar with rose-bengal and streptomycin.

Colonies of *Trichoderma viride* Pers. ex Fr. dominated plates poured with rhizosphere soil dilution from healthy plants, particularly between the third and seventh samplings (Fig. 1). This fungus was totally absent in the rhizosphere of SSMV-infected plants, until the ninth week after inoculation, when portions of roots sampled were dead. Fusaria were observed in plates poured with rhizosphere soil from both healthy and inoculated plants, except at the fourth sampling when all five replicate plates, poured with rhizosphere soil dilution from healthy plants, were totally devoid of fusaria. Fusaria were, however, found in greater numbers in the rhizosphere of SSMV-infected plants than in that of healthy plants. The number of colonies of these two fungi appearing in plates poured with 'control' soil dilution was very low (3 to 10%) at all samplings. Data regarding the other fungi encountered in this investigation are not presented here as they are not of any direct interest to the present investigation.

The definite suppression of *T. viride* in the rhizosphere of SSMV-infected plants during the active growth phase of the plant is very striking. The phenomenal number of colonies of this fungus appearing at the fourth, fifth and the sixth samplings in plates poured with rhizosphere soil dilution from healthy plants suggests heavy production of spores by this fungus in the rhizosphere of such plants. (Flowering occurred between the fourth and seventh samplings.) It is perhaps due to antibiosis[9] that there is an inverse relationship between the numbers of Fusaria and *T. viride* in the rhizosphere of healthy plants.

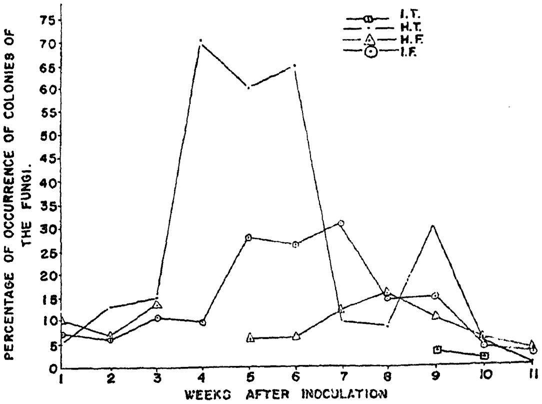

FIG. 1. Percentage of occurrence of colonies of *Trichoderma viriae* Pers. ex Fr. and *Fusarium* Lk. Spp., in the plates poured with rhizosphere soil of *Crotalaria juncea* L. plants. I.T.: Colonies of *T. viride* appearing in plates poured with rhizosphere soil of plants infected with southern sannhemp mosaic virus; H.T.: Colonies of *T. viride* from the rhizosphere of healthy plants, H.F.: Colonies of Fusaria from the rhizosphere of healthy plants; I.F.: Colonies of fusaria from the rhizosphere of infected plants.

The suppression of *T. viride*, an antagonist of several Fusaria, and the presence of Fusaria in greater numbers, in the rhizosphere of infected plants, suggests that the increased root-rots in virus-infected plants may partly be due to the suppression of possible antagonists of soil-borne plant pathogens in their rhizosphere.

I am deeply grateful to Professor T. S. Sadasivan for the encouragement and to Dr. C. B. Sulochana for valuable suggestions and guidance, and to the University of Madras for the award of a Studentship.

University Botany Laboratory,
Madras-5, *October* 29, 1968.
K. SIVASITHAMPARAM.**

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* Memoir No. 60 from the Centre for Advanced Studies in Botany.

**Present Address: Agricultural Research Station, Sita-Eliya, Nuwara-Eliya, Ceylon.

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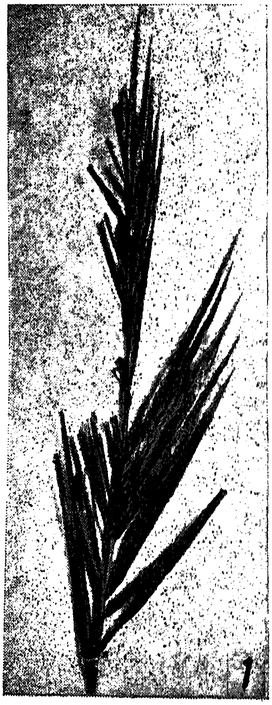
A NEW SPECIES OF *PESTALOTIA* ON THE LEAVES OF *PHOENIX RUPICOLA* ANDER.

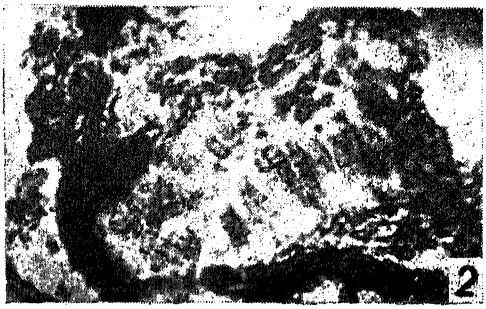
IN August 1967 the leaflets of *Phœnix rupicola* growing in various gardens of Allahabad started turning pearl gray. The infection started from the tip portion and proceeded towards the base (Fig. 1). Within few days it spread to a major portion of the lamina and assumed pallid mouse gray or pale olive gray colour. Diseased part was clearly separated from the healthy region by a prominent hair brown or fuscous brown narrow band. Longitudinal tearing of the diseased leaflets started from the tip portion after the infection covered nearly half of the leaflet. Finally the infected portion dried up and occasionally it got separated from the healthy part. Isolations from the diseased regions consistently resulted in a species of *Pestalotia*.

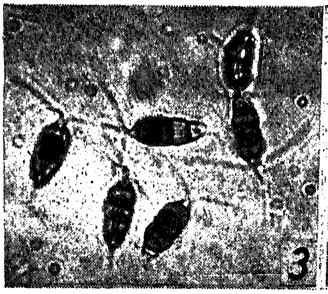
Detailed morphological studies carried out on the present species of *Pestalotia* revealed it to be distinct from other known species of the genus. Agarwal *et al.* (1959) reported *P. palmarum* occurring on *Phœnix sylvestris* at Jabalpur. The morphological characters of the present species differed from the above species also and thus it is being designated as *Pestalotia phœnicicola* sp. nov.

MORPHOLOGICAL CHARACTERS OF THE FUNGUS

Pestalotia Phœnicicola sp. nov.—Acervuli scattered, subepidermal, small, black, subglobose or lenticular, 80·2–128·5 μ (Fig. 2); conidia clavate-fusiform, 5-celled, generally erect, slightly constricted at septa, 20·4–24·6 × 6·2–8·2 μ; 3 intermediate cells yellow brown, 2 exterior cells hyaline or dilute yellow (Fig. 3), apical cell conic bearing 3 rarely 2 or 4 setulæ (Fig. 4); setulæ unbranched







FIGS. 1-4. Fig. 1. Photograph of diseased leaf. Fig. 2. Microphotograph of section of an acervulus, × 525. Fig. 3. Microphotograph of conidia, × 400. Fig. 4. Microphotograph of a conidium showing setulæ, × 625.

(very rarely branched), 8·2–22·4 μ; basal cell tapering into a pedicel, upto 5·2 μ long.

Hyphæ hyaline, branched, 2·1–4·2 μ in diameter.

Latin Translation

Pestalotia phœnicicola sp. nov.—Acervuli dispersi, subepidermales, nigri, subglobosi vel lenticulares; 80·2–128·5 μ; conidia clavato-fusiformia, vulgo erecta, 5-cellularia, paulum ad septa constricta, 20·4–24·6 × 6·2–8·2 μ; cellulæ intermediæ luteo-brunneæ, quarum duæ, exteriores hyalinæ vel dilute luteæ; cellula apicalis conica, ornata 3, rarius 2 vel 4, setulis simplicibus (rarius ramosis), 8·2–22·4 μ; cellula basalis fastigata in pedicellum, ad 5·2 μ longit. Hyphæ hyalinæ, ramosæ, 2·1–4·2 μ diam.

Parasitice insidet follis *Phœnix rupicola* in Alfred Park, ad Allahabad, mense August 1967, leg S.C. Typus positus in CMI ad Hortum Kewensem subnumero IMI 110651.

The authors are grateful to Prof. D. D. Pant for providing laboratory facilities and to Dr. H. Santapau for the Latin translation.

Botany Department, University of Allahabad, Allahabad,
SUDHIR CHANDRA.
R. N. TANDON.

September 17, 1968.

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AN ADDITION TO SPECIES OF *CONIOCHAETA*

DURING a collection tour, the authors recorded severe leaf-spot disease of *Buddelia asiatica* Linn. at Hyderabad. The infection was initiated as small yellow patches which gradually changed to dark-brown colour and ultimately they became fragile and got detached. Defoliation of the heavily infected leaves was also quite consistent. A species of *Coniochœta* was found to be invariably associated with such spots. The morphology of this isolate was significantly different from other known species of this genus.[1-6] The isolate shows some resemblance to *C. ellipsoidea* Udagawa and *C. saccardoi* (March.) Cain but it is distinctly different from these in size of the ascospores, shape of the ascus and absence of setæ from the perithecial beak. The species is, therefore, being described as a new species and designated as *C. microspora* spec, nov.

Colonies white at first turning cream with age; hyphæ hyaline, septate, branched, 1·0–2·3 μ wide; conidia not observed; perithecia superficial, aggregated or scattered, yellowish-cream-coloured with black beak and well-defined ostiole neck not clearly differentiated (Fig. 1), 283·9 × 263·3 (195·5–310·1 × 186·1–266·6) μ, peridium of the perithecium thin, membranous and transparent; asci 8-spored, cylindrical with a short stipe, often narrow towards both the ends, hyaline, unitunicate;

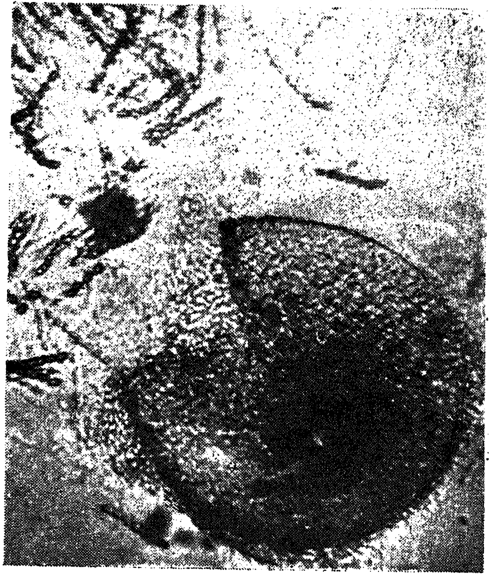

FIG. 1. Photomicrograph showing the perithecium, × 175.

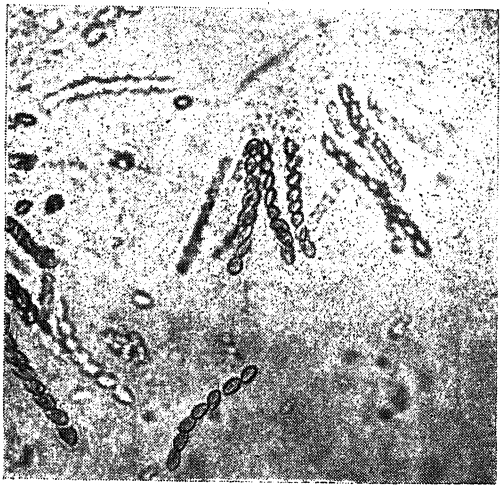

FIG. 2. Photomicrograph showing the asci and ascospores, × 450.

paraphyses short, septate, hyaline; ascospores arranged obliquely, uniseriate, compressed on two sides, narrowly ellipsoid in one view, broadly ellipsoid in other view, 8·3 × 4·9 (7·2–9·5 × 3·4–5·4) μ, hyaline at first becoming olivaceous-brown and finally dark-brown, 1-celled, slightly pointed at one end; germ slit extending narrowly the entire length of the spore.

Isolated from the leaves of *Buddelia asiatica*, culture deposited in C.M.I., Kew (C. No. 120810).

Latin Translation

Coloniæ initio albæ demum eburneæ; hyphæ hyalinæ, septatæ, ramosæ, 1·0–2·3 μ latæ; conidia non visa; perithecia superficialia, but arcte in aliquibus locis aggregata aut dispersa, luteo-eburnea, collo nigro haud clare determinato, ostiolo bene formato, peridio tenui, membraneo et diaphano, 283·9 × 263·3 (195·5–310·1 × 186·1–296·7) μ; asci 8-spori, cylindrici, ad efformandam stipitem brevem angustati; paraphyses filiformes, breves, septatæ, hyalinæ, unitunicatæ; ascospores oblique uniseriatæ, utrinque compressæ uno aspectu anguste ellipsoideæ altero aspectu late ellipsoideæ 8·3 × 4·9 (7·2–9·5 × 3·4–5·4) μ, initio hyalinæ, deinde olivaceo-brunneæ, germinali anguste longitudineum sporæ omnino decurrente.

Cultura in foliis *Buddeliæ asiaticæ* Linn., India, S. M. Reddy et K. S. Bilgrami, IMI 120810 typus.

Authors wish to express their deep sense of gratitude to Drs. G. C. Ainsworth and B. C. Booth for their help in the identification of the fungus and to Prof. Cecil F. Saldanha for the Latin diagnosis.

Department of Botany, S. M. Reddy.
University of Jodhpur, K. S. Bilgrami.
India, *September* 16, 1968.

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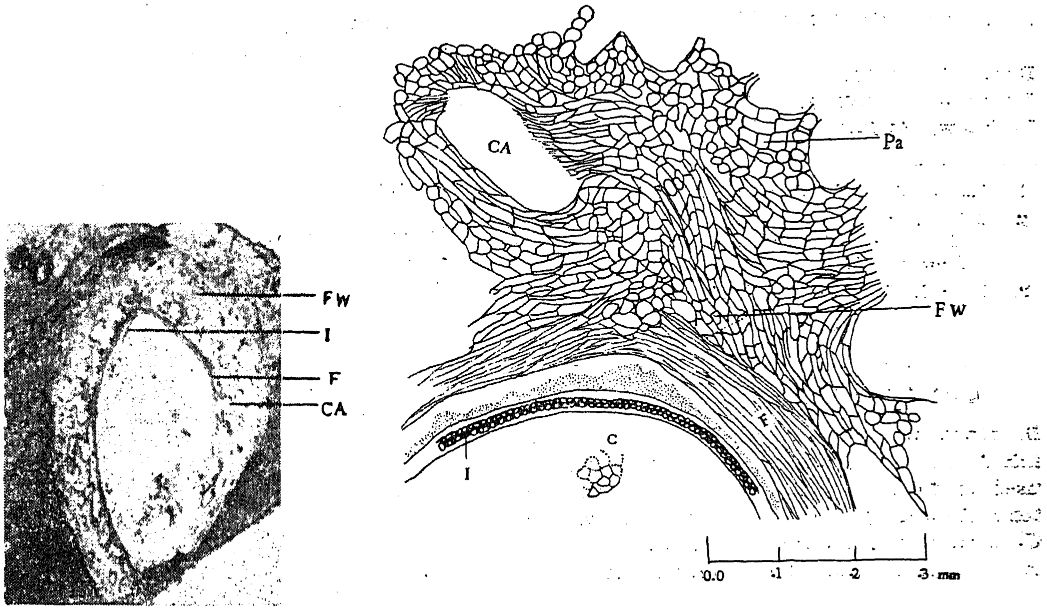
A FOSSIL FRUIT FROM THE DECCAN INTERTRAPPEAN SERIES

In December 1967, one of us (B. S. T.) visited Mohgaon-Kalan, Chhindwara District, M.P., and collected fossiliferous rocks which lie scattered there. These obviously belong to Deccan Intertrappean Series. On sectioning, a chert from the above locality revealed a well-preserved fruit which is reported here (Fig. 1).



FIGS. 1–2. Fig. 1. Longitudinal section of the fruit, × *ca.* 11·5. Fig. 2. A part of the fruit in longitudinal section. CA, air cavities; C, seed cavity; I, integument of the seed; F, fibrous layer of the fruit wall; FW, fruit wall; Pa, parenchymatous cells.

Fruit one-seeded, somewhat oval in shape, 5 mm. long and 4 mm. broad. Fruit wall externally smooth. Some epidermal cells can be seen but they are not well preserved. The wall is about 1·5 to 2 mm. thick with well-preserved, thin-walled compact parenchyma. It has large air cavities of variable dimensions, sometimes two or more of these fuse together. Beneath the parenchymatous zone is present a distinct zone consisting of thick-walled fibrous cells which are placed longitudinally. The fibrous zone is about 89·1 μ thick and is nearly uniform throughout (Figs. 1, 2).

The seed has a single coat and a large cavity. The seedcoat consists of two layers of thick-walled cells. These cells are somewhat oval, sometimes they are flattened. Below the integument is a large cavity, about half the size of the fruit, within this cavity are present parenchymatous cells in patches. The embryo of the seed is not seen (Figs. 1, 2).

Although the exact affinities of the fruit are not ascertainable, yet the large air-spaces in the parenchymatous tissue, and the thick inner fibrous layer of the fruit wall suggest that the fruit probably belonged to an angiosperm that grew in aquatic or marsh situations.

As far as the authors are aware, this fruit is not comparable to any fossil angiospermous fruit previously reported.[1-3]

Dept. of Botany, B. S. Trivedi.
Lucknow University, C. L. Verma.
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ALGAE AS FOOD OF *BARBUS CONCHONIUS* HAM. *ET* BUCH.

B. conchonius—the Rosy Barb—is a common fish found in the streams of Nagpur and it is used as food. A study of the intestinal contents showed species of *Spirogyra, Cosmarium, Closterium* and *Phacus*. As it was found that in the case of snails the intestinal contents do not give a correct idea of the food, it was thought worthwhile to find out the algæ actually used as food by the fish. For this purpose, triplicate sets, each of two fishes (about 4–6 cm. in length) were maintained in aquaria and studied as in the case of the snails.[1]

It was found that the spp. of *Spirogyra* (veg.), *Mougeotia* (veg.), *Oscillatoria, Spirulina, Nostoc* (veg.), *Anabœna* (veg.), *Anabœnopsis* (veg.), and *Vaucheria* (veg.), are digested by the fish. Excreta revealed that spp. of *Pithophora* (veg.), *Dichotomosiphon* (veg.), *Merismopedia* and diatoms were partially digested, while a number of algæ, *e.g.*, spp. of *Eudorina, Ulothrix, Stigeoclonium, Cœlastrum, Scenedesmus, Oedogonium, Rhizoclonium, Cladophora, Cosmarium* (veg. and zygospores), *Microcystis, Dichothrix, Euglena, Phacus, Trachelomonas* and akinetes and spores or zygospores of these algæ were unaffected. It may be mentioned here that the filaments of *Oedogonium* spp. when freed from the excreta occasionally formed zoospores. The fish did not eat some algæ such as *Chara corallina, C. zeylanica, Nitella hyalina;* probably, because they were too big to be gulped.

When a mixture of *Spirogyra* (veg.) and *Pithophora* (veg.) is given as food, the fish first feeds on *Spirogyra* and starts feeding on *Pithophora* only when there is no more *Spirogyra*, thus showing preference in the case of filamentous algæ. When fed with different wholly or partially digestible algæ for a month, the fish showed a maximum increase in weight in cases when the food was a mixture of *Spirogyra* (veg.) and *Oscillatoria*.

In conclusion it may be pointed out that a simple analysis of the intestinal gut contents of this fish does not give a correct idea of its food habits.

Thanks are due to Prof. J. H. Sabnis of the Department of Zoology for the identification of the fish.

Department of Botany, N. D. Kamat.
College of Science,
Nagpur, *July* 18, 1968.

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REVIEWS AND NOTICES OF BOOKS

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w York), 1968. Pp. x + 355. Price $ 16.75.

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Thermodynamics for Chemists and Biologists. By Terrell L. Hill. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1968. Pp. 181. Price 52.00.

Designed as a text for graduate chemical thermodynamics courses, this book presents chemists, and many biologists, with special topics not included in undergraduate physical chemistry. The reader should have some prior acquaintance with thermodynamics and statistical mechanics.

Following the trend in physical chemistry, especially in research, the author has chosen the topics to overlap physical chemistry with biochemistry and molecular biology. Although primarily thermodynamic in character, the book introduces examples at the molecular level to create a mixture of thermodynamics and statistical mechanics.

The contents of this book are : 1. Thermodynamics of Surfaces ; 2. Thermodynamics of Gas Adsorption ; 3. Thermodynamics of Elastic Systems ; 4. Imperfect Gases and Solutions, Osmotic Pressure and the Donnan Equilibrium ; 5. Thermodynamics of an Electric Field ; 6. Thermodynamics of Small Systems ; and 7. Introduction to Irreversible Thermodynamics.

C. V. R.

The Mango (*A Hand-Book*). (Indian Council of Agricultural Research), 1967. Pp. 210. Price Rs. 11·50.

This book contains comprehensive accounts of the history, origin and botany of the mango, its propagation, cultivation, manurial requirements and irrigation practices, the methods of grading, marketing and storage of the fruit, and the diseases and pests attacking the crop. Accurate descriptions are also given of some of the most important mango varieties of India. The articles in this book are written by eminent scientists in the field. The book will be of interest to mango-growers and horticulturists.

C. V. R.

Tropical Crops: Dicotyledons (Vols. 1 and 2). By J. W. Purseglove. (Published by Messrs. Longmans, Green and Co., Ltd., 48, Grosvenor Street, London W 1), 1968. Pp.: Vol. 1, 1-332; Vol. 2, 333-719. Price 50 *sh.* net each Volume.

This two-volume publication provides an up-to-date text dealing with tropical dicotyledonous crops on a world basis. The crops dealt with are those grown on a field scale either for local consumption or for export.

The crops are arranged under their plant families, which, with their genera and species, are given in alphabetical order. The space given to each crop is dependent upon its importance on a world scale and the amount of research which has been devoted to it. Thus some minor crops occupy two pages only whereas many major crops occupy as many as 30–40 pages. The text of each of the major crops is arranged under the heads: useful products, systematics, chromosome numbers, origin and distribution, ecology, structure, pollination, chemical composition, propagation, husbandry, major diseases and pests, improvement. There are 102 illustrations.

The author who has worked and travelled extensively in the tropics of Africa and the Far East, gives first-hand information on the subject. It will be a very useful reference book not only to students of botany and agronomy but also to those interested in agricultural development in tropical countries. Even a layman will find the reading interesting as he will find that many of the plants dealt with are familiar to him.

A. S. G.

Oestrogenic Constituents of Forage Plants. By E. M. Bickoff. (Published by the Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Bucks, England), Pp. 39. Price 10 *sh.*

It is well known by now that certain plant species contain substances whose effects on animals are characteristic of the animal oestrogens, and that infertility in animals may follow the excessive ingestion of oestrogen containing forages. It may be pointed out that some three decades ago breeding abnormalities in sheep became a major problem in Australia, and investigations showed the association of infertility in sheep with oestrogenic potency in subterranean clover (*Trifolium subterranean*) which was the common forage for sheep. The infertility disease has come to be known as the "clover disease" and is attributed to an isoflavone, genistein, found in clover.

It would appear that the problem of infertility of farm animals associated with oestrogenic pastures is more serious, and has been reported from countries throughout the world. Coumestrol, the predominant oestrogen in lucerne appears to be several times more oestrogenic to sheep than the isoflavones. Genetic studies have shown that mutants can be produced which are very low in plant oestrogens, and this offers promise of eventual control of the problem. Further, interrelationships between plant disease and oestrogenicity in the forage may be very important in relation to reproductive problems and these need more detailed study.

This C.A.B. monograph under review presents an up-to-date picture of the whole problem and is a valuable booklet to workers in this field of study. The bibliography contains 169 references on the subject upto 1967.

A. S. G.

Books Received

Text-Book of Physical Chemistry (3rd Revised Edition). By P. L. Soni and O. P. Dharmarha. (Sultan Chand and Sons, Delhi-6), 1968. Pp. iii + 728. Price: Part I, Rs. 6·00; Part II, Rs. 6·75; Complete, Rs. 10·00.

Text-Book of Organic Chemistry (IV Revised Edition). By P. L. Soni. (Sultan Chand and Sons, Delhi-6), 1968. Pp. v + 875. Price: Vol. I, Rs. 6·50; Vol. II, Rs. 6·50; Complete Rs. 13·00.

Text-Book of Inorganic Chemistry (III Revised Edition). By P. L. Soni. (Sultan Chand and Sons, Delhi-6), 1968. Pp. vii + 944. Price: Vol. I, Rs. 6·50; Vol. II, Rs. 6·50; Complete, Rs. 12·50.

Transactions of the Bose Research Institute—Golden Jubilee Issue (1917-1967). (Bose Institute, 93/1, Acharya Profulla Chandra Road, Calcutta-9), 1967. Pp. vi + 245. Price Rs. 6·00.

Selective Toxicity (4th Edition). By A. Albert. (Methuen and Co. Ltd., 11, New Fetter Lane, London, E.C. 4), 1968. Pp. xvii + 531. Price 90 *sh.*

Elements of Geological Maps. By S. K. Chadha. (Allied Printers, Pacca Danga Park, Jammu Tawi), 1968. Pp. 68. Price Rs. 8·95.

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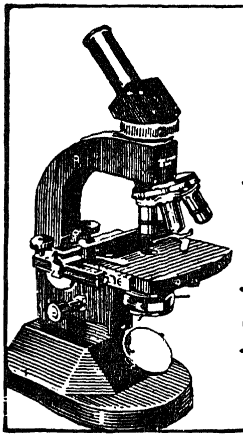

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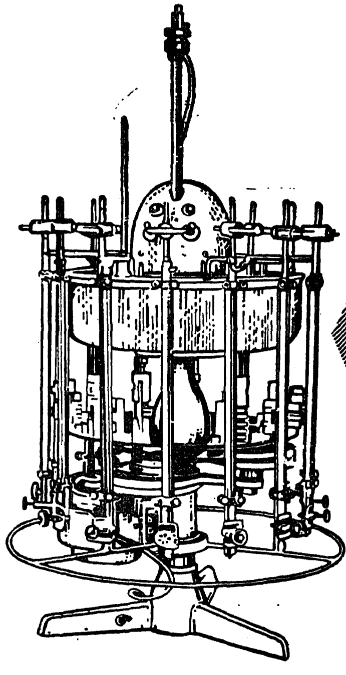

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THE BASIC CAUSES OF THE LARGE-SCALE DEFICIENCY IN THE SOUTH-WEST MONSOON RAINFALL OVER INDIA IN 1965 AND 1966

C. RAMASWAMY

C/o The Observatory, Lodi Road, New Delhi-3

INTRODUCTION

THE years 1965 and 1966 will be remembered in Indian history as two successive years in which the failure of the south-west monsoon had a disastrous effect on Indian economy. The present article* is an attempt to find out the basic causes of this large-scale deficiency in the monsoon rainfall.

Figures 1(*a*) and (*b*) show the departures from normal expressed as percentages of the total normal rainfall during the four monsoon months June to September in 1965 and 1966 in the different political subdivisions of India. Figure 1(c) which is in respect of 1967 presents, by way of contrast, a year of very good monsoon. Figure 1(*d*) represents the political subdivisions of India which experienced deficient rainfall *both* in 1965 and 1966.

JUNE, 1965 AND 1966

In June 1965, the monsoon advanced very slowly into India. The usual monsoon depressions did not also develop and influence the weather. On the other hand, in June 1966, the monsoon advanced into the country near about the normal dates and three monsoon depressions affected the Indian weather. One of these depressions developed in the Bay of Bengal near lat. 15° N., long. 88° E.—in a latitude far too low for the month. An analysis of the past cases based on an India Meteorological Department publication[1] shows that during a 70-year period, there were only 9 years in which a cyclonic disturbance did not develop in the month of June and only 2 disturbances developed in such a low latitude as in June 1966.

Analysis of the *daily* as well as the *mean* flow-patterns over the northern hemisphere shows that in June 1965, the meandering high-level westerlies dominated the circulation over Northern and Central India and 'forced' the high-level easterlies over the country to remain *mainly* in regions south of lat. 15° N. Consequently, the onward march of the monsoon into Northern India, west of 88° E., was considerably retarded.

The vertical time-sections revealed that the low-pressure systems which developed at sea-level in June 1965 did not intensify into monsoon depressions as there were no middle or upper tropospheric wave-perturbations of sufficient depth and intensity or significant Easterly Jet maxima in the upper troposphere which could induce[2] the development of a depression at sea-level in June 1965. The depression which developed in the abnormally low latitude on 2 June 1966, filled up within 36 hours without entering inland. This abnormality and the rather unusual tracks of the two other depressions, which developed in June 1966, led to serious deficiency of rainfall over most of peninsular India in that month.

JULY, 1965 AND 1966

In July 1965, there were no monsoon depressions in the first fortnight. July 1966, on the other hand, was characterised by a remarkable "break in the monsoon" in the same period. Figure 2 shows the flow-patterns over the northern hemisphere on 5 July 1966 at the 500 mb (approximately 6 km.) level. The pronounced cellular structure of the flow-patterns over the whole of Asia, seen in the diagram, is in striking contrast to the flow-patterns over the rest of the northern hemisphere. The "cut-off" cyclonic vortex over the Bay of Bengal is another interesting feature. The elongation of the trough over Indo-Pakistan is, as the author had pointed out on an earlier occasion,[3] a dynamic necessity consequent on the weak basic flow over the Tibetan plateau.

The pronounced instability in the middle-latitude westerlies seen in Fig. 2 led to a very weak monsoon situation over the major part of the Indian sub-continent. The weak monsoon conditions along and near the Konkan coast during this period in the wake of the earlier serious deficiency in rainfall over the same area in June 1966, led to very serious water-scarcity in the city of Bombay. The problem, however, got solved by an interesting meteorological development which is brought out by Fig. 3. The diagram shows a vertical time-section over Bombay and the progressive strengthening of the monsoon along the Konkan coast between 5 and 18 July 1966 as wave-perturbations of sufficient depth and intensity in the high-level easterlies and wind-

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* Based on a lecture delivered at the Annual Session of the Indian Academy of Sciences held at Ahmedabad between 22nd and 24th December, 1968.

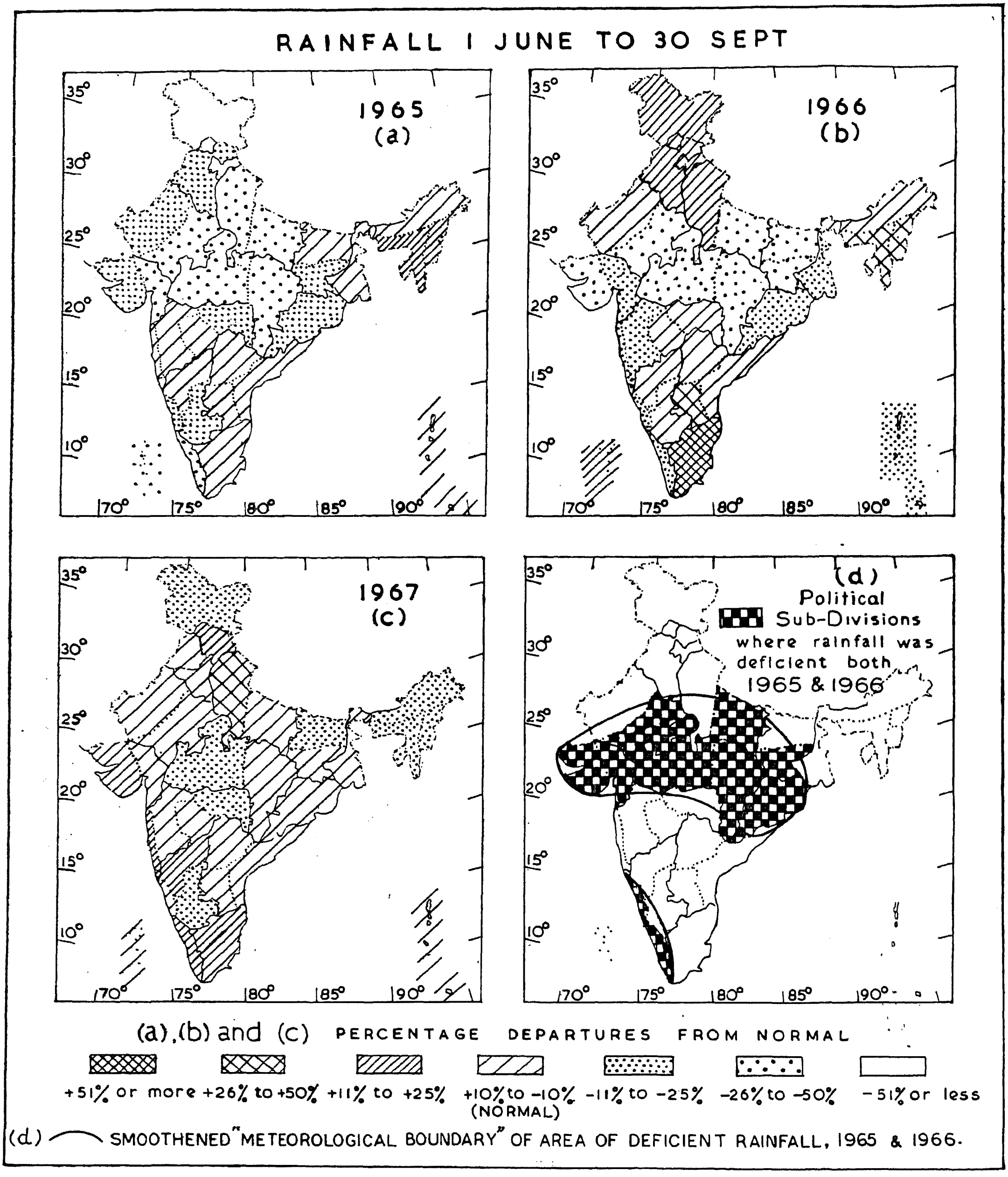

RAINFALL 1 JUNE TO 30 SEPT
1965
(a)
1966
(b)
1967
(c)
(d)
Political
Sub-Divisions where rainfall was deficient both 1965 & 1966
35°
30°
25°
20°
15°
10°
70°
75°
80°
85°
90°
(a),(b) and (c) PERCENTAGE DEPARTURES FROM NORMAL
+51% or more
+26% to +50%
+11% to +25%
+10% to −10% (NORMAL)
−11% to −25%
−26% to −50%
−51% or less
(d) SMOOTHENED "METEOROLOGICAL BOUNDARY" OF AREA OF DEFICIENT RAINFALL, 1965 & 1966.

FIG. 1. Note that the smoothened meteorological boundary of the area of deficient rainfall in North and Central India in Fig. (*d*) roughly resembles the area where strong monsoon conditions prevail in association with monsoon depressions moving in the usual westnorthwesterly or northwesterly direction from the Bay of Bengal.

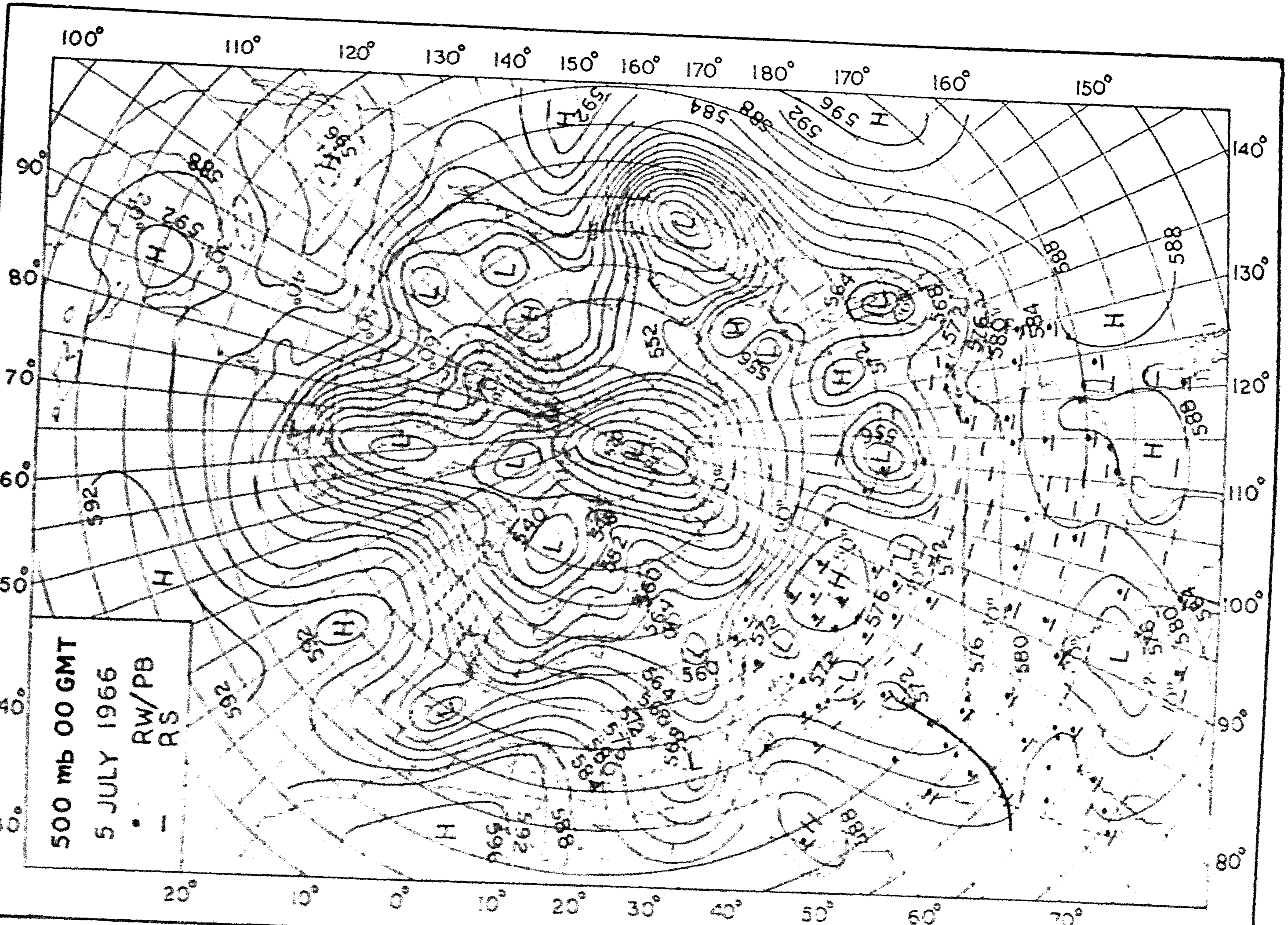
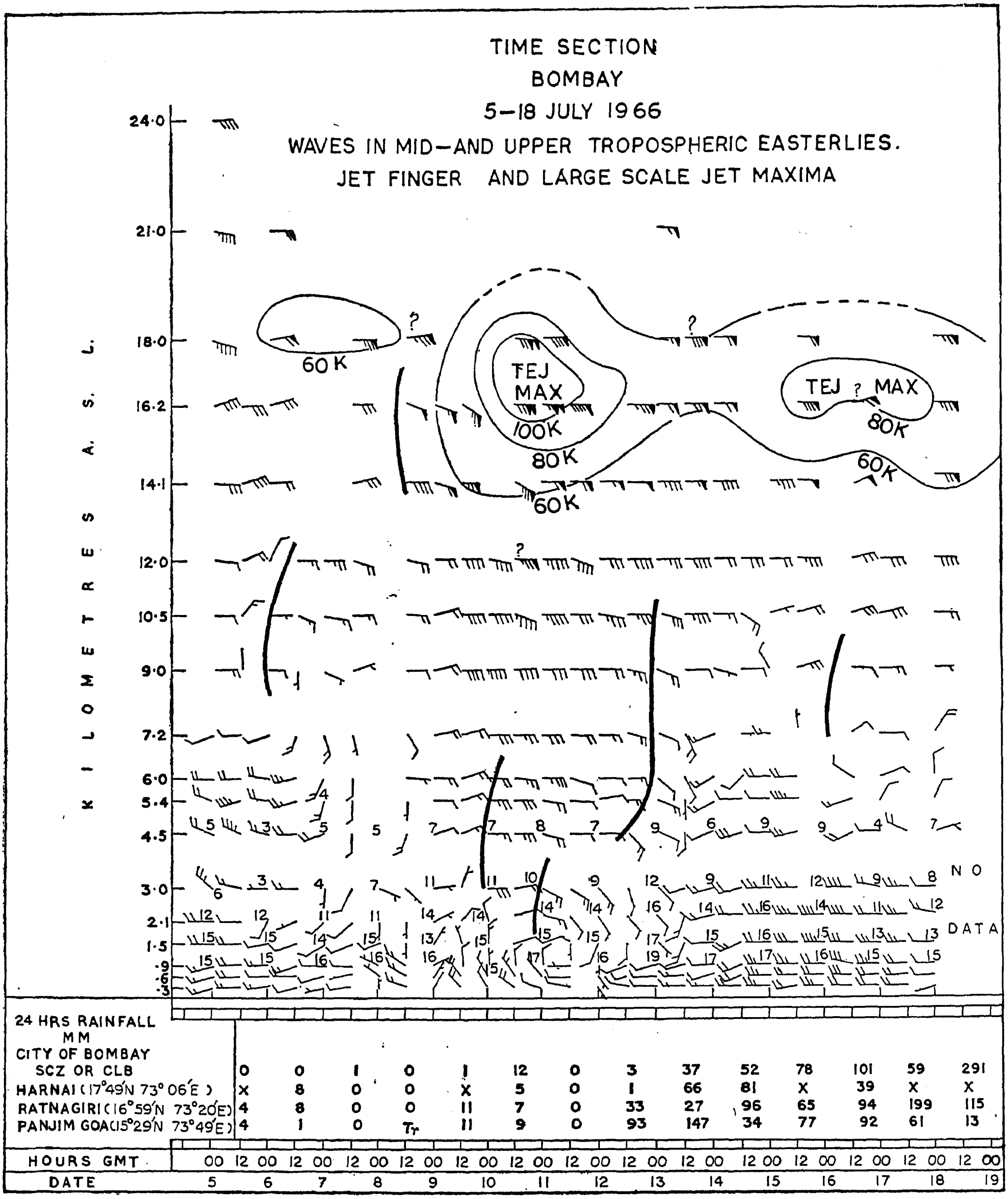


FIG. 2 Analysis over area between 30° E and 130° E is based on data received through the Northern Hemisphere Exchange Centre at Delhi. The analysis outside the above mentioned area is based on printed Northern Hemisphere charts published by the U.S.S.R. Hydromet. Service. Observations of winds and geopotential heights have not been plotted in the above diagram to avoid undue congestion. The shaded circles and dashes south of 35° N over Asia indicate stations where wind and radiosonde observations respectively of 00 GMT on 5th July 1966 were actually available for analysis.



24 HRS RAINFALL MM														
CITY OF BOMBAY SCZ OR CLB	0	0	1	0	1	12	0	3	37	52	78	101	59	291
HARNAI (17°49′N 73° 06′E)	X	8	0	0	X	5	0	1	66	81	X	39	X	X
RATNAGIRI (16°59′N 73°20′E)	4	8	0	0	11	7	0	33	27	96	65	94	199	115
PANJIM GOA (15°29′N 73°49′E)	4	1	0	Tr	11	9	0	93	147	34	77	92	61	13

FIG. 3. The symbol K indicates wind-speed in knots. The continuous thin lines are isotachs or lines of equal wind-speed of 60 knots or more. The area covered by the 60 knots isotach between 6th and 8th may be considered as a 'Jet-Finger'. The figures in thin print are the mixing-ratio values. The term TEJ stands for Tropical Easterly Jet. The thick continuous lines are trough-lines. The figures in thick print indicate rainfall in 24 hours ending at 0300 hours GMT (0830 I.S.T.). They have been plotted at the mid-point of the 24-hour period, namely, 15 GMT, on each day.

maxima† in large-scale Easterly Jets and a "Jet-Finger" moved westwards across the Konkan coast. The net effect of these moving high-level systems on the monsoon air over the Konkan coast in the lower troposphere was complex and we shall not go into details. We would merely emphasize that Fig. 3

---

† All Indian upper air data utilised in this investigation have been checked against the scrutinised Registers of the India Meteorological Department.

reveals how high-level divergence augmented convection of monsoon air along the Konkan coast. During the break-period, as is usual[1] in such situations, a feeble low pressure system was moving west-north-westwards across the extreme south of the Peninsula. As the system moved into north-east Arabian Sea, it temporarily became accentuated—although not into a depression—as a result of the high-level divergence referred to earlier. The marked strengthening of the westerly winds over Bombay in the lower troposphere associated with the movement of this low pressure system must have augmented the orographic contribution[5] to the rainfall. The near-constancy in the mixing ratio of the humid monsoon air over Bombay during the dry as well as the wet period and the increase in the rainfall over Bombay between the 18th and 19th in spite of the weakening of the winds in the lower troposphere high-light the importance of the dynamics of the high-level systems in the development of monsoon rainfall over and near the Western Ghats.[6]

THE PROLONGED BREAK IN AUGUST 1965

August 1965 was characterised by a prolonged break for a fortnight which caused serious deficiency in the rainfall over India outside sub-Himalayan West Bengal, Assam and the extreme south of the Peninsula. The *mean* flow-pattern over Asia at the 500 mb level during this prolonged break has already been published by us elsewhere.[7] On the equatorward side of the *mean* trough over Northern India during this spell, a ridge of high from Arabia and Iran extended into the central parts of the country and the northern half of peninsular India. Deficiencies of 80 to 95% in rainfall occurred in the rear of the *mean* trough and the area of the ridge where we should expect *large-scale sinking motion*, suppressing the upward motion of monsoon air. We would add that the daily Northern Hemispheric Charts for 500 mb level for this break-period showed the same type of cellular structure in the middle-latitude westerlies and large-amplitude troughs in the westerlies over Northern India as on 5 July 1966 in Fig. 2.

Srinivasan[8] has studied the meteorological satellite cloud-pictures during this prolonged break. According to him, the basic relative distribution of large-scale cloudiness over the Indian monsoon area *even* during the prolonged break is similar to the one during active or normal monsoon days.

AUGUST 1966

The outstanding features in August 1966 were the lack of development of monsoon depressions to activate the monsoon and a "break" in the last week. Feeble low pressure areas developed over north-east India at sea-level and moved along the monsoon trough over the Gangetic plain but none of them intensified into a depression. The available evidence indicates that waves in the easterlies in the middle and upper troposphere over and near north-east India were either too feeble or were not in the appropriate positions to cause sufficient cyclogenesis. Further, although there were "Jet-Fingers" in the upper troposphere over West Bengal, there were *no marked jet maxima or minima.* It may be added that during a 70-year period in the past there were only 2 years when there were no monsoon depressions in the month of August.

The daily northern hemispheric flow-patterns, associated with the "break" in the last week of August 1966, were similar to those discussed earlier in this article and elsewhere.[7]

SEPTEMBER, 1965 AND 1966

The deficiency of rainfall in these two months was associated with a rapid change in the high-level flow-patterns after the first 10 or 12 days of each of these months. The sub-tropical high shifted to a latitude much lower than usual following the re-entry of the sub-tropical westerly jetstream into north-west Pakistan and extreme north-west India. During the same period, there was also frequent development of low pressure cells at sea-level in the Tropical West Pacific and the South China Sea. These developed in much larger numbers and lower latitudes than in September 1967, a very good monsoon year. Many of these "lows" developed into cyclonic storms or typhoons and low pressure waves moved westwards into the South Bay of Bengal in low latitudes. Wave-perturbations in middle and upper tropospheric easterlies intensified two of these lows—one in 1965 and another in 1966—into depressions. The one in September 1966 later developed into a severe cyclone and hit East Pakistan. A depression also developed over a very low latitude in south-east Arabian Sea in September 1966. All these cyclonic disturbances had very abnormal northeastward tracks as they were steered by the sub-tropical high which itself was in too low a latitudinal position in the second half of the month. Many of these abnormalities nearly or actually broke previous records for September and led to serious rainfall deficiency over several parts of the country.

The upper tropospheric charts for September showed many other interesting features. For instance, at the 100 mb (approximately 16 km.) level, the easterly circulation over India was much less pronounced and over more southerly latitudes in September 1966 than in September 1967, a month of very good monsoon. The associated westerly circulation to the north of the Indian monsoon area was also in striking contrast in these two months but we shall not go into these aspects in detail here.

Deficiency in Kerala and Coastal Mysore

The maximum deficiency in monsoon rainfall occurred in this area in August 1966 (*minus* 55 to 60%). The same area experienced excellent monsoon in August 1967. In August 1966, the westerlies over Trivandrum (08° 29′ N, 76° 57′ E) were about 3 km. in depth and had also frequent northerly components while in August 1967 they were nearly 6 km. in depth and were significantly more westerly. The mixing ratio at 1·5 km. level was however not significantly lower in August 1966 than in August 1967. But the most remarkable feature was that, in August 1966, there were practically no wave-perturbations in the upper tropospheric easterlies over that area while, in August 1967, a large number of waves moved westwards between 7 and 14 km. a.s.l.

Mixing-Ratio in Relation to Weak and Active Monsoon

A study of the mixing-ratio at the 850 mb (1·5 km.) level over Nagpur (21° 06′ N, 79° 03′ E) in the 4 monsoon months, June to September, in 1965, 1966 and 1967 shows that the activity of the monsoon after it establishes itself over any area is, by and large, determined not by the differences in the water-vapour content of the air but by the presence or absence of factors which lift the monsoon air to produce rainfall. This is also confirmed by our earlier findings in regard to Bombay (*vide* Fig. 3). In the onset and retreating phase of the monsoon, however, differences may arise especially in dry inland areas depending upon the date of onset/withdrawal of the monsoon.

Conclusions

From the above analysis, it will be evident that important basic causes of the large-scale deficiency in the monsoon rainfall in 1965 and 1966 have to be sought for in the middle and upper tropospheric westerlies and easterlies and in the abnormalities created by them, several of which *actually or nearly broke previous records.* The fact that so many abnormalities occurred during the 8 monsoon months we have studied, seems to explain why such large-scale deficiency in rainfall occurred in *two successive years,* 1965 and 1966. Our analysis also shows that the deficiency in rainfall did not occur due to insufficiency of water vapour in the monsoon air.

It is most desirable that we should be in a position to state *why* the high-level westerlies and easterlies exhibited the unique features we have discussed. As Lorenz[9] has, however, very recently said in his IMO lecture, we do not have, even today, a full explanation of the distribution of the easterly and westerly winds in the atmosphere. More observations and further research are therefore the only hopeful solutions to our problem. As a first step, we would suggest simulation of the tropical upper easterlies in laboratory experiments by a massive, though expensive, effort. A more intensive study of the nature and characteristics of instability in the middle-latitude westerlies to the north of India during the south-west monsoon period is also urgently required.

Acknowledgements

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EVIDENCE FOR CHEMISORPTION OF NITROGEN ON IRON POWDER AT LOW TEMPERATURES

MISS P. RUKMANI, B. VISWANATHAN, V. SRINIVASAN AND M. V. C. SASTRI
Department of Chemistry, Indian Institute of Technology, Madras-36

IT is known[1] that carbon monoxide is chemisorbed as a complete unimolecular layer at low temperatures (around −190° C.) on metals like iron, cobalt and nickel and this property has been used to estimate the area of such metal atoms exposed on the surface of catalysts. The total carbon monoxide adsorption at low temperatures consists of a combination of chemisorbed and physically adsorbed gas. The amount of chemisorption has been computed by taking the difference between the total carbon monoxide and the total nitrogen adsorptions, both at the same temperature, on the basis[2] that the physical adsorption of carbon monoxide and nitrogen are the same at the same temperature. A further assumption has been that the chemisorption of carbon monoxide does not affect the subsequent physical adsorption of gases. This assumption has been supported by Joy and Dorling[3] and by Srikant[4] in their investigations on iron catalysts. However, evidence contrary to this has been reported by a number of workers[5,6] in the case of cobalt catalysts. The present work attempts to elucidate the effect of chemisorbed carbon monoxide on the subsequent physical adsorption of nitrogen and also to obtain evidence for the chemisorption of nitrogen at low temperatures on pure iron powder and based on the results obtained a modified method for estimating the active metal atoms on the surface of the catalysts has been suggested.

The catalyst employed in the present study was obtained by thorough reduction of pure iron oxide in a stream of pure dry hydrogen at 500° C. The results reported here refer to adsorption by about 6·35 grams of the reduced catalyst. The adsorption measurements were carried out in an apparatus similar to the one employed by Srinivasan.[7] Solid CO_2 in acetone and liquid nitrogen were used to obtain temperatures of −78° C. and −195° C. respectively. The catalyst was completely evacuated at 500° C. and at 10^{-5} mm. Hg pressure for 8 hours and was then subjected to the following sequence of operations to obtain the isotherms presented in **Fig. 1.**

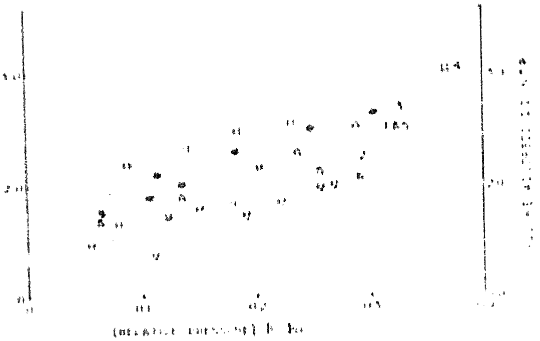

FIG. 1. Adsorption isotherms of nitrogen and of carbon monoxide on pure iron powder at −195° C.

(1) Determination of the adsorption of nitrogen on the evacuated surface at −195° C. (isotherm 1).

(2) Evacuation at −78° C. for one hour followed by the determination of the adsorption of nitrogen at −195° C. (isotherm 2).

(3) Evacuation at −78° C. for one hour and subsequent determination of the carbon monoxide adsorption at −195° C. (isotherm 3).

(4) Regeneration of the catalyst by evacuation at −195° C. for one hour, soaking in hydrogen and slowly raising the temperature to 500° C. and maintenance at 500° C. for four hours in hydrogen, followed by evacuation at 500° C. for eight hours.

(5) Determination of carbon monoxide adsorption at −195° C. on the bare surface (isotherm 4).

(6) Evacuation for one hour at −78° C. followed by determination of readsorption of carbon monoxide at −195° C. (isotherm 5).

(7) Evacuation at −78° C. for one hour followed by determination of nitrogen adsorption at −195° C. (isotherm 6).

(8) The catalyst was regenerated as in (4) and the experiments (1) to (7) were repeated and the results were found reproducible.

It is seen from Fig. 1, that out of the total amount of nitrogen adsorbed at –195° C. a small amount (0·2 c.c. NTP, difference between isotherms 1 and 2) resists desorption at –78° C. Based on the considerations[1] of heats of adsorption, physically adsorbed nitrogen at –195° C. would be expected to desorb completely at –78° C. The amount resisting desorption may therefore be attributed to chemisorption of nitrogen. Similar observations on nickel catalysts have been interpreted by Kokes and Emmett[8] as being due to a limited chemisorption of nitrogen at –195° C. Kokes[9] has presented evidence indicative of nitrogen chemisorption on iron at –195° C. through a comparison of nitrogen and argon adsorptions. The occurrence of the chemisorption of nitrogen on iron at –195°C. has also been inferred by Ponec and Knor[10] from electrical conductivity measurements.

It is also seen from isotherm (3) that the presence of 0·2 c.c. of nitrogen on the surface results in a decrease of the carbon monoxide adsorption to the same extent [0·22 c.c. NTP, difference between isotherms (4) and (3)] indicating that the chemisorbed nitrogen blocks partially the sites originally available for the chemisorption of carbon monoxide. As the suppression of carbon monoxide is equivalent to the amount of nitrogen present and taking into account that the molecular dimensions of nitrogen and carbon monoxide are almost the same, it can be concluded that the nitrogen chemisorption at low temperatures may be molecular. It is also evident that the chemisorption of nitrogen does not suppress the physical adsorption of carbon monoxide and hence may not be expected to suppress its own physical adsorption.

If the desorption of carbon monoxide at –78° C. had resulted only in the physically adsorbed gas coming off from the surface, then the readsorption isotherm should have coincided with the physical adsorption isotherm of nitrogen (isotherm 2). A perusal of the readsorption isotherm of carbon monoxide (isotherm 5) shows that it coincides with the nitrogen adsorption (isotherm 1) on the bare surface. This would indicate that the desorption of carbon monoxide at –78° C. removes, in addition to the physically adsorbed carbon monoxide, the weakly chemisorbed carbon monoxide [difference between isotherms (5) and (2)] leaving behind only the strongly chemisorbed carbon monoxide [difference between isotherms (4) and (5)]. This conclusion is in accordance with the views of Joy and Dorling and of Sastri *et al.*[6] in the case of iron and cobalt catalysts.

A perusal of the adsorption of nitrogen on carbon monoxide covered surface (isotherm 6) indicates that the strongly chemisorbed carbon monoxide suppresses the subsequent physical adsorption of nitrogen as reported by a number of workers.

In conclusion, the present study points clearly to the occurrence of the chemisorption of nitrogen on iron at –195° C. and also indicates that such chemisorption does not affect its own subsequent physical adsorption. This study would lead to an important modification in the method for the estimation of active metal atoms on the surface of a catalyst. On catalysts where chemisorption of nitrogen occurs at –195° C. it is suggested that the carbon monoxide chemisorption must be evaluated by taking the difference between total carbon monoxide adsorption (isotherm 4) and the readsorption isotherm of nitrogen at –195° C. after evacuation at –78° C. This would lead to a more accurate estimate of the metal atoms on the surface.

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LETTERS TO THE EDITOR

POLAROGRAPHIC STUDY OF TITANIUM REDUCTION IN PROTOCATECHUIC ACID

Habashi has reported the polarographic study of titanium (IV) reduction in salicylic and sulpho-salicylic acid media.[1] The present study deals with the reduction of titanium (IV) in protocatechuic acid (PCA) medium.

A semi-manual Du-Bellay d.c. polarograph was used, maintaining temperature constant at 30 ± 0·1° C. H cell and saturated calomel electrode were employed, '*m*' and '*t*' of the capillary being 1·49 mg./sec. and 4·5 sec. respectively on open circuit. Stock solutions of 0·14 M protocatechuic acid (manufactured by the City Chemical Corporation of New York) and 0·01 M titanium (IV) solution containing 8% sulphuric acid were prepared. Ionic strength was kept constant at 0·1 M by the appropriate addition of 1·0 M sodium perchlorate.

The study was carried out over 0·90 to 10·0 pH range, keeping titanium and PCA concentrations constant at 1·0 mM and 0·1 M respectively. Four different waves were obtained. Table I shows the effect of pH on the half-wave potentials of these waves.

The First Wave (A).—It is observed between 0·9 and 2·5 pH, and the half-wave potential changes linearly with pH. It disappears after 2·5 pH, is irreversible and no current concentration linearity is observed. This seems to be a kinetic wave similar to the first wave obtained for titanium (IV) in salicylic acid medium.[1] The hydrolised forms of titanium and its complex can be written as $\mathrm{Ti(OH)}^{3+}$ and $\mathrm{Ti(OH)Rn}^{(3-n)}$ respectively.

The Second Wave (B).—Only one wave is obtained between 3·0 and 4·5 pH. The half-wave potential shifts linearly towards increasing negative potentials with pH. The electrode reaction is reversible and diffusion controlled, involving one electron reduction. Ilkovic equation for current concentration linearity is satisfactorily observed.

The changes in half-wave potentials with ligand concentration could be studied only for this wave. It has been reported by spectrophotometric studies that the complex is of the form TiR_2 in this pH region.[2] A plot of $E_{\frac{1}{2}}$ *vs.* log (PCA) yielded a straight line. Employing the equation for half-wave potentials for reversible processes involving only dissolved species,[3] $(p - q) = 1$ is obtained, where p = number of ligands attached to Ti(IV) and q = number of ligands attached to Ti(III). As the complex is TiR_2, $p = 2$; inserting the value

Table I

Effect of pH on titanium reduction waves

No.	pH	Wave (A) $E_{\frac{1}{2}}$	Wave (B) $E_{\frac{1}{2}}$	Wave (C) $E_{\frac{1}{2}}$	Wave (D) $E_{\frac{1}{2}}$	Remarks
1	0·90	−0·435	(−0·963)			
2	1·20	−0·475	(−1·05)	..	..	Double wave
3	1·50	−0·538	..	..	..	do.
4	2·00	−0·600	..	..	..	Only one wave
5	2·50	−0·75	..	..	..	do.
6	3·00	..	−0·925	..	..	do.
7	3·50	..	−1·02	..	..	do.
8	4·00	..	−1·075	..	..	do.
9	4·50	..	−1·113	..	..	do.
10	5·05	..	..	..	..	do.
11	5·50	..	..	−0·875	−1·20	Double wave
12	6·15	..	..	−0·875	−1·35	do.
13	6·95	..	..	0·873	−1·40	do.
14	8·00	..	..	−0·85	−1·40	do.
15	9·00	..	..	−0·813	−1·375	do.
16	10·00	..	..	−0·825	−1·363	do.
17	11·00	..	..	−0·825	−1·40	do.
				..	−1·40	One wave

The ensuing discussion is based on the hydrolysis mechanism of titanium (IV) at different pH, proposed earlier by Habashi.[1]

of p as 2, q comes out to be 1, indicating that for this pH range; PCA is forming a complex with Ti(III) ion, in 1 : 1 ratio.

A graph of $E_{\frac{1}{2}}$ *vs.* pH gave a variation of 125 mV/pH indicating that for each titanium ion, two hydrogen ions are consumed in the electrode reaction. The corresponding hydrolised species of Ti(IV) and its complex can be written as Ti(OH)_2^{2+} or TiO^{2+} and $\text{Ti(OH)}_2\text{–Rn}^{(2-n)+}$ or $\text{TiORn}^{(2-n)+}$ respectively.

Taking into consideration that, one electron is involved in the electrode reaction, two hydrogen ions are consumed, titanium (IV) complex is of the form TiR_2 and titanium (III) complex is of the form TiR, the overall electrode reaction may be written as

$$\text{TiOR}_2^{--} + e + 2\text{H}^+ \rightleftharpoons \text{TiOR}^- + \text{H}_2\text{R}$$

The titanium (IV) complex, red in colour, is very stable for this pH range, the current remaining constant for a day and then only marginally increasing afterwards.

The Third (C) and the Fourth (D) Waves.—From 5·05 pH, double waves are obtained upto 10·0 pH. The wave C disappears at pH 11·0. It is irreversible while the wave D is reversible and diffusion controlled, involving one electron reduction. For both the waves, half-wave potentials remain nearly constant over the entire pH range. The hydrolysed species of Ti(IV) for wave C is of the form Ti(OH)_3^+; and extending the hydrolysis mechanism for wave D is, Ti(OH)_4 in solution in the presence of the complexing ligand PCA. The corresponding complexes will be $\text{Ti(OH)}_3\text{Rn}^{(1-n)+}$ and Ti(OH)_4^- Rn respectively.

The titanium (IV) complex for wave D is stable only for a day, after which the current rises rapidly probably due to air-oxidation of the acid on the alkaline side.

In the earlier work, in salicylic and sulphosalicylic acid medium, titanium (IV) reduction gave rise to two and three waves respectively over the pH range studied. By employing PCA, however, four reduction waves are obtained for Ti(IV) over the pH range 0·90 to 10·0. These waves are explained by extending the hydrolysis mechanism of Ti(IV) proposed earlier in studies with salicylic and sulphosalicylic acids.

Thanks are due to Dr. V. T. Athavale, Head, Analytical Division, Bhabha Atomic Research Centre, Trombay, Bombay-74, for his keen interest in this work.

Analytical Division,
Bhabha Atomic Research Centre,
Modular Laboratories,
Trombay, Bombay-74,
October 25, 1968.

R. G. Dhaneshwar.
L. R. Zarapkar.

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VAPOUR GROWTH OF TELLURIUM SINGLE CRYSTALS

Abstract

Single crystals of Te have been grown from the vapour. Crystals grown by the method described grew as hexagonal rods. The faces of the crystals have been identified by etching as the $\{10\bar{1}0\}$ prism faces. Etch pit density shows that these crystals are more perfect than those grown from the melt.

Most of the optical and electrical measurements made on Te have been made on crystals grown from melt using high purity metal. The crystals are cleaved and/or polished and etched. For some work it is desirable to study crystal properties using "as grown" faces, eliminating the effects due to cleaving and polishing. As a part of a programme of the study of the growth and perfection of single crystals of metals and alloys this work had been undertaken. This paper reports a method of growing single crystals of Te.

The tellurium metal used was supplied by M/s. Light and Co., U.K. Their analysis shows the metal to be 99·995% pure. The temperature of the furnace was recorded using Pt.—Pt. 10% Rh thermocouple.

In this method the crystals were grown in elbow-shaped pyrex tubes having a diameter of 2 cm., wall thickness = 1·5 mm. length of the arm $\simeq$ 10 cm. The tube was bent at an angle of 120° and had a notch just before the bend towards the closed end (Fig. 1). Tellurium metal was made into bits, cleaned in dilute HCl to remove oxide adhering to the metal, washed in distilled water, rinsed in alcohol and ether and air-dried. Then the metal was filled into the tube and the tube was evacuated to a pressure of $\sim 10^{-4}$ mm. Hg before it was sealed. Figure 1 shows the line diagram of the set-up. The temperature of the furnace was gradually raised to 520° C. and kept steady for about 20 hr. It was then cooled gradually by reducing the current and brought to room temperature. The tube was then carefully removed and cut at the closed end with a glass-cutter. On gently tapping the glass tube, crystals having hexagonal shape got detached from the walls of the tubes. The size of the crystals was about 1 cm. in length and 1 to 2 mm. in cross-section. Figure 2 shows the hexagonal crystals obtained. To see whether the habit faces were the prism planes the crystals were etched at 100° C. in conc. H_2SO_4.[1] The shapes of the pits were similar to those observed on the cleaved $(10\bar{1}0)$ faces etched in the same way. It was observed that the etch pit density in the case of vapour-grown crystals was quite low compared to that in the case of cleaved crystals.

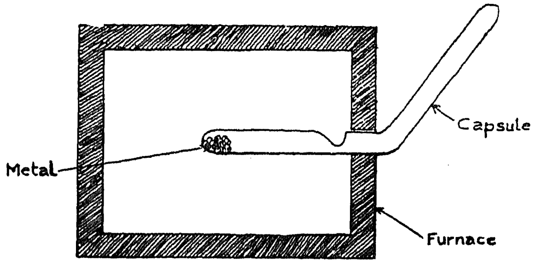

FIG. 1. Schematic diagram of the set up for the growth of Te crystals from vapour

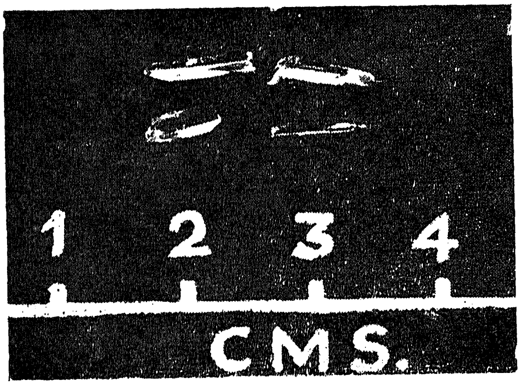

FIG. 2. Te single crystals about 1 cm. in length.

The vapour growth method described here has yet to be developed to give large crystals of good quality.

The temperature of the source has a marked effect on the size and shape of the crystals.

The authors are grateful to Prof. N. S. Pandya for his encouragement and guidance during the course of this work. Of the authors B. S. Shah is grateful to the U.G.C. for the award of a Senior Research Fellowship and E. Mathai to the M.S. University of Baroda for the award of a Research Assistantship.

Physics Department, B. S. Shah.
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IONISATION CONSTANTS OF SOME 4-ALKYLTHIOANILINES IN WATER AND 45% (w/w) DIOXANE-WATER MIXTURE

In general the variation of ionisation constant with dielectric constant of the medium appears to be slight for anilines, because the reaction involves only a proton shift and not the creation of a new charge.

$$BH^+ + S \rightleftharpoons SH^+ + B$$

A number of equations have been proposed[1,2] to correlate the change in acid strength with the dielectric constant of the solvent. All such relationships seem to break down in the case of solvent mixtures involving solvents such as dioxane and water. Wooten and Hammett[3] ascribe this failure to the preferential orientation of the dioxane molecules around the solute, thus lowering the dielectric constant in the vicinity of the reaction centre.

We present here the ionisation constants of some 4-alkylthioanilines in water and 45% (w/w) dioxane-water mixture.

TABLE

Comparison of the strengths of 4-alkylthioanilines in water and 45% dioxane-water (w/w) mixture at 30°

Compound	pK_a in water	pK_a in 45% Dioxane-water mixture
A	4·31	3·59
B	4·00	3·50
C	3·87	3·35
D	3·38	3·08
E	2·56	2·80
F	0·35	2·71

A: 4-Methylthioaniline, B: 4-Ethylthioaniline, C: 4-Isopropylthioaniline D: 3-Chloro-4-methylthioaniline, E: 2-Chloro-4-methylthioaniline, F: 2, 6-Dichloro-4 methylthioaniline.

The anilines were prepared by the methods described in the literature. The ionisation constants in water were determined spectrophotometrically by the method of Robinson[4] at 30°. The ionisation constants in 45% (w/w) dioxane-water mixture were determined at 30° by a method similar to that devised by Bates,[5] using a hydrogen electrode in conjunction with the silver-silver chloride electrode.

Our results indicate that the pK_a values are lower in the dioxane-water mixture (except 2-chloro-, and 2, 6-dichloro-4-methylthioanilines) than in water. James and Knox[6] also made similar observations and found that in the case of anilines, passing from water to 70% dioxane caused the conjugate acid of the aniline to become one pK_a unit stronger. The increase in the acidity shown by the cation acids has been attributed to the greater proton affinity of the water in dioxane-water mixtures than in water.[7]

In an attempt to correlate the change in pK_a with change in the solvent, Grunwald and Berkowitz[8] observed that change in the pK_a of a compound depends both on the solvent and the structure of the compound. Our results also show that the magnitude of the decrease in the pK_a is not uniform for all the anilines. In fact, 2-chloro- and 2, 6-dichloro-4-methylthioanilines show considerable increase in pK_a.

However, a linear relationship is observed (Fig. 1) when pK_a values in water for the anilines studied, are plotted against the corresponding values in 45% dioxane-water mixture.

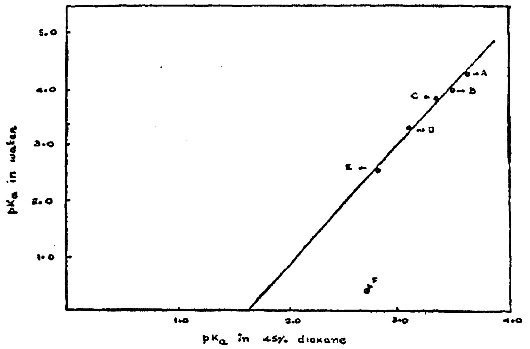

FIG. 1 Correlation of pK_a in water and 45% dioxane for some thioanilines at 30°.

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Pachaiyappa's College, Miss N. Vanajakshi.
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THE KINETICS OF THE CHLORINATION OF AROMATIC COMPOUNDS

The reaction between chlorine and an aromatic compound in acetic acid medium is generally known to be of the second order and involve neutral molecules of chlorine.[1-4] However, the precise rate constants and Arrhenius parameters for the chlorination of various types of aromatic compounds have not been determined so far. We have therefore undertaken a systematic study of the kinetics of the reaction in non-aqueous solvents, in order to evaluate these parameters. This communication deals with the chlorination of parachloroanisole in dry acetic acid.

Each kinetic run was carried out in several ground-glass-stoppered test-tubes (capacity 20 ml.) under the usual thermostatic conditions. The solution of parachloroanisole was initially taken in these tubes. The solution of chlorine was initially taken in another set of calibrated (5 ml.) ground-glass-stoppered test-tubes into which the solution was introduced from a large syringe (50 ml.) and not from a conventional pipette, to avoid loss of chlorine. Air-space above the liquid in all the tubes was kept at a minimum. The unreacted chlorine present after various time intervals was estimated iodometrically. During a run the loss of chlorine did not exceed 1%.

Figure 1 shows some typical plots for second-order kinetics. In the equation[5] used for the plots, a and b are, respectively, the initial concentrations of parachloroanisole and chlorine and x is the amount of chlorine reacted in time t. The plots are linear and pass through the origin. The values of the second-order rate constant (k_2), deduced from the slopes of the lines, are 27·1, 27·5 and $27 \cdot 7 \times 10^{-3}$ M^{-1} Sec^{-1}. These are constant within the limits of experimental error.

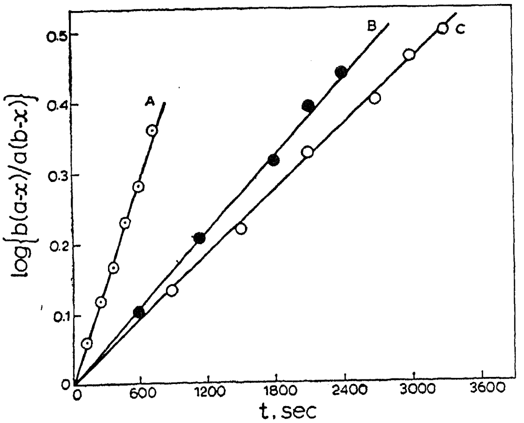

FIG. 1. Chlorination of parachloroanisole in acetic acid at 26° C.; Plots showing second-order kinetics:
A, $a = 6 \cdot 67 \times 10^{-2}$ M, $b = 2 \cdot 85 \times 10^{-2}$ M;
B, $a = 2 \cdot 77 \times 10^{-2}$ M, $b = 1 \cdot 18 \times 10^{-2}$ M;
C, $a = 2 \cdot 00 \times 10^{-2}$ M, $b = 0 \cdot 74 \times 10^{-2}$ M.

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Physical Chem. Dept., S. KALACHANDRA.
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FLAVONOIDS OF THE SEEDS OF *CROTALARIA RETUSA* AND *CROTALARIA STRIATA*

IN continuation of our earlier reports[1,2] on the flavonoids of certain *Crotalaria* species (Family: Leguminosæ), we now record in brief the results of our study of the pigments of the seeds of *C. retusa* Linn. and *C. striata* DC (= *C. mucronata* Desv.).

Dried seeds of *C. retusa* and *C. striata* were coarsely powdered in a Wiley cutter mill, and the powder extracted four times with hot ethanol (80%). The total extracts in each case were concentrated *in vacuo* to remove all the solvent, and the aqueous concentrate was repeatedly shaken with petroleum ether, ether, ethyl acetate and methyl ethyl ketone in succession. The residue from the petroleum ether layer in both the cases contained β-sitosterol, obtained after adsorption chromatography on alumina. The residue from the ether layer of *C. retusa* was found to contain free quercetin only, while in the case of *C. striata*, luteolin was identified. The residue from the ethyl acetate layer of *C. retusa* was crystallised from methanol-ether, when a yellow crystalline solid, m.p. 226–28° was obtained; yield: ca. 0·3%. On recrystallisation twice from dilute alcohol, it came out as yellow needles, m.p. 228–30° and answered all reactions for a flavonol 3-O-glycoside. On hydrolysis with 7% sulphuric acid for two hours, it yielded quercetin (identified by direct comparison of its colour reactions and co-chromatography in different solvent systems and m.m.p. of its acetate with an authentic sample of quercetin penta acetate), and glucose (through its osazone and paper chromatography). Thus, the pigment was identified as isoquercitrin and the identity confirmed through its IR and NMR curves and by mixed m.p. with an authentic sample of isoquercitrin. No flavonoid C-glycoside could be identified in *C. retusa*.

The residue from the ethyl acetate layer of *C. striata* on paper chromatography in water and aqueous acetic acid systems showed the presence of two flavonoid C-glycosides. The R_f values in six solvent systems indicated that vitexin and its O-xyloside were present. The residue from the methyl ethyl ketone layer containing larger proportion of the flavonoids could not be crystallised, but on hydrolysis with dilute mineral acid in the usual way, it yielded yellow needles, m.p. 262–64°, whose identity as vitexin was established by direct comparison and co-chromatography with an authentic sample of vitexin and getting apigenin as the aglucone on treatment with HI in phenol medium. The sugar obtained after hydrolysis was identified as xylose and hence, the second pigment was concluded to be vitexin O-xyloside. This was confirmed by its R_f values in different solvent systems, behaviour under UV and co-chromatography with an authentic sample of vitexin O-xyloside.

The isolation of isoquercitrin from the seeds of *C. retusa* is recorded for the first time, and it is interesting to note that the seeds of

C. retusa biosynthesise only a flavonol-O-glycoside and no flavonoid-C-glycoside unlike the other species so far examined.

We are grateful to Prof. L. Hörhammer, Munich, for the IR and NMR comparison of isoquercitrin and to Dr. K. Ganapathy, Regional Research Laboratory, Jammu, for the seeds of *C. retusa*.

Dept. of Chemistry, S. SANKARA SUBRAMANIAN.
J.I.P.M.E.R., S. NAGARAJAN.
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September 17, 1968.

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AMINO-ACID REQUIREMENTS OF A CELL STRAIN MFS$_8$-IV

ABSTRACT

The cell strain MFS$_8$-IV has been studied for its amino-acid requirements. The results show that arginine, cystine, glutamine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine and valine are essential for maximum growth.

THERE are a number of reports in literature on the amino-acid requirements of cells cultured *in vitro*. Most of these studies have been carried out using basal media which contained dialysed or undialysed sera in varying proportions. Recently in our laboratory, it has been possible to maintain routinely, a cell strain MFS$_8$-IV, a variant of a cell line MFS$_8$[1] in Eagle's medium—BME[2] supplemented by horse serum (ES) at 0·5% level. MFS$_8$-IV could also be maintained in serum-free medium for at least 72 hours. It was thought that this cell system could be used with advantage for the study of amino-acid requirements of cells without any interference by serum or serum proteins. The present communication reports the results with thirteen amino-acids.

The cell strain MFS$_8$-IV was maintained in 4 oz. prescription bottles in a stock medium consisting of BME and 0·5% ES. For the experiments, the cells from the bottle were removed by short exposure to 0·25% trypsin solution and suspended in the stock medium. Aliquots of the cell suspension, each containing $1 \cdot 5 \times 10^5$ cells in 1·5 ml. of the stock medium were planted in rimless tubes (5″ × 5/8″). The tubes were incubated at 37° C. for 2 hr.[3] Two hours later when the cells have attached to the glass surface, the medium in the tubes was removed aseptically and replaced by experimental medium. Growth in the tubes which have been incubated for 48 hours was determined in terms of nuclear counts using the method described by Mashelkar and Wagh.[3]

TABLE I
Optimum concentration of amino-acids for maximum growth

Amino-acid	Optimum concentration$^+$ (mM)			Per cent. increase‡
	L-929*	Hela†	MFS$_8$-IV	
L-Arginine ..	0·05	0·05	0·2	85
L-Cystine ..	0·01	0·03	0·05	77
L-Glutamine ..	0·2–0·5	1·0–2·0	8·0	§
L-Histidine ..	0·01	0·02	0·1	67
L-Isoleucine ..	0·1	0·1	0·2	133
L-Leucine ..	0·05	0·1	0·2	80
L-Lysine ..	0·05	0·1	0·8	128
L-Methionine ..	0·02	0·03	0·5	100
L-Phenylalanine	0·02	0·05	0·1	60
L-Threonine ..	0·05	0·1	0·2	60
L-Tryptophan ..	0·00125	0·01	0·2	60
L-Tyrosine ..	0·02	0·03	0·1	60
L-Valine ..	0·05	0·1	0·1	190

$^+$ Represents the minimum concentration of amino-acid tested, which gave the maximum growth, * Eagle H[4], † Eagle H[5], ‡ Represents per cent. increase in nuclear count at optimum concentration of test amino-acid over that in absence of the same, § Cells failed to survive in absence of glutamine.

Table I gives the optimum concentrations of amino-acids for growth of MFS$_8$-IV cells. It also gives the values reported by Eagle for Hela and strain L cells.[4,5] It is evident that all the thirteen amino-acids tested are essential for growth of MFS$_8$-IV cells. The results thus agree with those of Eagle for Hela[4] and strain L cells[5] as also with those of Foley and Drolet[6] with S-180 cell strains. It is, however, observed that the values obtained in the present studies are higher than those reported by Eagle and by Foley. It may be possible that the lower values obtained in their studies might be due to use of 10% serum in the medium as against absence of serum in the present studies. In our laboratory a cell strain MFS$_{83}$ derived from a mouse fibrosarcoma also showed requirement for thirteen amino-acids for maximum protein synthesis.[7] Rose[8] has shown that eight amino-acids are essential for maintaining nitrogen balance in feeding experiments in man. The fact that the cells *in vitro* require 5 more amino-acids, has been explained by Eagle.[9] It thus appears that the requirement of arginine, cystine, histidine, glutamine and tyrosine for MFS$_8$-IV cells *in vitro* may be explained as due to either loss of biosynthetic capacity of these cells or to slow rate of biosynthesis of these amino-acids with a result that these amino-acids are lost to the medium in quantities which exceed the biosynthetic capacity of cells.

Biology Division, A. S. SHIRODKAR.
Cancer Research Institute, B. N. MASHELKAR.
Tata Memorial Centre, Parel,
Bombay-12, *September* 2, 1968.

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MALT EXTRACT AS A SOURCE OF CARBON FOR LARGE-SCALE PRODUCTION OF *RHIZOBIUM* INOCULANTS

VARIOUS synthetic media have been used to grow *Rhizobium*, the usual carbon sources being sucrose or mannitol.[1–8] These media serve well on a laboratory scale but when legume inoculants are manufactured on a large-scale, the development of a cheap indigenous source of carbon is necessary. Criteria of a good carbon source are, faster rate of rhizobial multiplication and low production of gum in a liquid medium. In these experiments malt-extract (non-diastatic B.P.) kindly supplied by Mohan Meakin Breweries Ltd., Ghaziabad, and containing 56% maltose and 4·19% protein, was used as the sole carbon source in a proportion of 1·0% in the usual yeast extract liquid medium. Nine efficient strains of rhizobia were grown in the medium and were continuously shaken in a rotary shaker for 72 hours at 28–30° C. Standard yeast-extract-mannitol medium was used as control.

Plate counts of each species were made by standard dilution procedures on the yeast-extract-mannitol agar containing 1 in 40,000 of Congo red (Fred, Baldwin and McCoy, 1932). The results are presented in Table I.

TABLE I

Counts of different strains of rhizobia in yeast-extract-mannitol and yeast-extract-malt-extract medium. (Average of duplicates × 10⁹)

Species		Host	Yeast-extract-mannitol medium	Yeast-extract-malt extract medium
R. trifolii	..	Berseem	10·1	11·4
R. meliloti	..	Lucerne	1·18	1·3
R. leguminosarum	..	Pea	67·0	78·0
R. japonicum	..	Soybean	0·148	0·138
R. sp. (Cowpea gp.)		Moong	7·8	9·9
,,	..	Groundnut	97·0	72·0
,,	..	Gram	0·148	0·156
,,	..	Cowpea	0·167	0·179

From the results presented in Table I it can be observed that the growth in the two media is generally comparable though in some cases the counts are much more in the yeast-extract-malt-extract medium than in the standard medium depending upon the strains used. According to Australian standards[5] counts greater than 100×16^{6} viable bacterial/ml. are enough to inoculate peat so that viable counts obtained by using the yeast-extract-malt-extract medium are quite high for preparation of soil inoculants.

The growth of rhizobium in malt-extract medium has two additional advantages. Firstly, there is low gum production and thus handling of the cultures is facilitated. Secondly, cost of mass production can be reduced about twenty fold.

The counts obtained using Rhizobia from gram, soy-bean and cowpea were much lower than with the other organisms. Experiments to evolve suitable media for the slow growers and to test the efficiencies of different strains grown in yeast-extract-malt-extract broth are in progress.

The authors are grateful to Dr. W. V. B. Sundara Rao for guidance and to Dr. P. H. Graham, F.A.O. expert in this Division for going through the manuscript.

Division of Microbiology, V. ISWARAN.
Indian Agricultural K. S. JAUHRI.
Research Institute,
Delhi-12, *September* 26, 1968.

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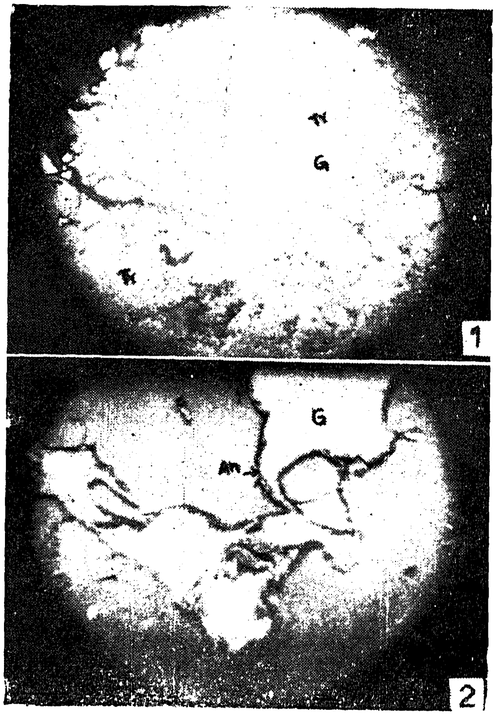
OCCURRENCE OF GALENA IN JOGIMARDI TRAP, CHITALDRUG SCHIST BELT, MYSORE STATE

CHITALDRUG Schist belt is one of the metamorphic belts of Dharwar rock formations in Mysore State. It is situated between lat. 12° 20″ and 15° 50″ and long. 75° 20″ and 76° 45″ extending for a maximum length of 350 km. and a maximum width of 35 km. The main rock formations of this belt are chloritic schists, ferruginous quartzites and conglomerates, which are intruded by a basic rock locally known as the Jogimardi trap. This trap runs in the form of a hillock in a direction parallel to the general strike of the schistose and quartzitic rocks, which is N-S. In addition to this are found small intrusive bodies similar to the Jogimardi trap, cutting through the chlorite schists at a number of places.

Sulphide mineralization was earlier reported at many places along the Chitaldrug Schist belt and galena was reported from acid rocks of igneous origin (especially quartz veins). It was also believed that only the milk-white quartz veins could be considered as important lead sulphide localities. However, in the course of a detailed geological mapping of a part of Chitaldrug Schist belt around *Ingaldhalu*. (Lat. 14° 11″ and Long. 76° 27″ E.), the authors have noted an occurrence of galena in the Jogimardi trap rocks. The occurrence is in the form of disseminated grains. A sample was studied in detail under reflecting microscope and the mineral galena was confirmed by its high reflectivity, white colour, characteristic triangular pits and isotropism, and etch tests (Fig. 1). Along its edges, at some places anglesite has developed in the form of a rim (Fig. 2). The mineral galena is definitely localized in the trap rock. However, in the neighbourhood of galena, occurrence of a white patchy substance with a highly irregular boundary suggesting gradual merging with the adjacent trap material was noticed. At first this could easily be mistaken for quartz segregation. Detailed examination of a transparent section of this patch has revealed that the white patchy material is an alteration product of the trap rock and is serpentinous in nature.



FIGS. 1–2. Fig. 1. Galena (G) in trap rock (Tr.). Polarized illumination, × 4. Fig. 2. Anglesite (An, rim around galena (G). Polarized illumination, × 30.

The authors believe that in Chitaldrug Schist belt lead sulphide mineralization is not restricted to quartz veins alone but it is also traceable to the Jogimardi trap rocks which are highly basic in nature. It is the presumption of the authors that lead was originally present in the solutions responsible for the Jogimardi trap and at the time of crystallisation and solidification of the trap, the mineral was separated as sulphide from the same along with other volatile emanations, and was crystallised in the trap. The volatile emanations with which lead was associated in the final phase of crystllisation of the Jogimardi trap brought about the alteration of the trap into serpentinous material. Alteration of galena to anglesite along the boundary is also believed to be due to the process of oxidation brought about by the volatiles.

The following sequence of events is suggested: Separation of lead sulphide along with volatile emanations from the magma—Solidification of magma as Jogimardi trap—Crystallisation of galena—Action of volatiles on the trap rock and galena.

One of us (K. V. S. A.) is thankful to the C.S.I.R. for a Fellowship.

Dept. of Geology, K. V. S. Acharyulu.
Andhra University, C. Borreswara Rao.
July 24, 1968.

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PLANTLET FORMATION IN TISSUE CULTURES FROM LIGNOTUBERS OF *EUCALYPTUS CITRIODORA* HOOK.

Eucalyptus citriodora Hook. is a tree introduced from Australia and grown as an avenue tree or in plantations for the production of its essential oil.[1] In view of great variations in oil content from tree to tree, this laboratory has been interested in vegetative propagation of this species in order to have high oil yielding clones. Attempts made to multiply the high yielding trees from stem cutting were not successful. Therefore tissue culture technique was applied for vegetative multiplication. The results are reported in this paper.

E. citriodora has a swollen outgrowth, called lignotuber, on the main axis at the region corresponding to the rootstock. The lignotuber plays a role in the survival of *Eucalytus* species after the main trunk is cut off or destroyed by bush fire.

The tissues from the main aerial stem, from the lignotuber, and from the root tips of germinated seeds, were grown on Murashige's inorganic salts medium supplemented with sucrose (2%), *meso*-inositol (0·5%), coconut water (15%), *amino-acids*, *vitamins*, 2-naphthoxyacetic acid (1 ppm. and 10 ppm.), and agar (0·4%).

Root Tissue.—The initiation of callus started in one to two weeks but the rate of development was enhanced on subsequent subculture of the callus. At 1 ppm naphthoxyacetic acid the callus formed roots, but at 10 ppm a non-granular mass of undifferentiated tissue was formed.

Stem Tissue.—The callus developed only after prolonged contact with the medium and was initiated only in a medium supplemented with 10 ppm naphthoxyacetic acid. But it could be maintained later at 1 ppm of the hormone. The callus also required subculturing every 3-4 weeks in order to obtain rapid growth. The callus was granular as if formed by conglomerations of somewhat spherical, 2-3 mm. broad, whitish, bud-like pellets.

Lignotuber Tissue.—It produced a granular mass of callus, at first somewhat similar to that obtained from stem tissue. However, in 3-4 weeks growth in medium containing 1 ppm naphthoxyacetic acid, each bud-like segment of the callus mass became transformed into a green, aerial bud (Fig. 1) which in the subsequent 3-4 weeks developed into a plantlet. Thus, several plantlets were formed which produced roots. The results obtained with the lignotuber tissue culture have significance in two respects: (1) Within the same medium composition and auxin concentration the ability to form plantlets is inherent in the tissue from which the callus originated, and (2) the ability of lignotubers of *E. citriodora* to form plantlets *in vitro* offers a potential which can be exploited in raising high yielding clones. Work is in progress to standardize this technique for commerce.

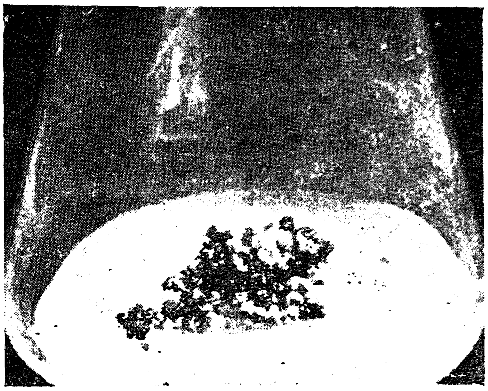

Fig. 1

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NUCLEOLAR CHROMOSOMES IN *PHYLLACTINIA YARWOODII* PATW.

DURING cytological studies on the *Dalbergia* mildew *Phyllactinia yarwoodii* Patwardhan[4] (= *P. dalbergiæ* Pirozynski) several features, were noticed and these are briefly described here.

The diploid nucleus in the young ascus undergoes a long resting period during which noticeable changes in the size of asci take place. The diploid nucleus enlarges considerably (5–9 μ in diam.) followed by breaking up of the chromatin network into fine chromatin threads which are evenly distributed within the nuclear membrane. These chromatin threads contract after entering the synaptic stage and appear as deeply stained bivalent chromosomes accompanied by a distinct nucleolus. In the early stages of prophase chromomeres are clearly observed which however disappear during subsequent stages. By late pachytene the nucleolus turns vacuolate and loses its original homogeneous character.

At diplotene the chromosomes become shorter due to contraction and the nucleolus appears as a faintly stained, vacuolated oval area. The five bivalents with their different sizes are clearly visible at this stage. The shortest bivalent is attached to the nucleolus (Fig. 1) and therefore may be called the nucleolar bivalent—the pair which is primarily responsible for the organization of the nucleolus after each nuclear division.

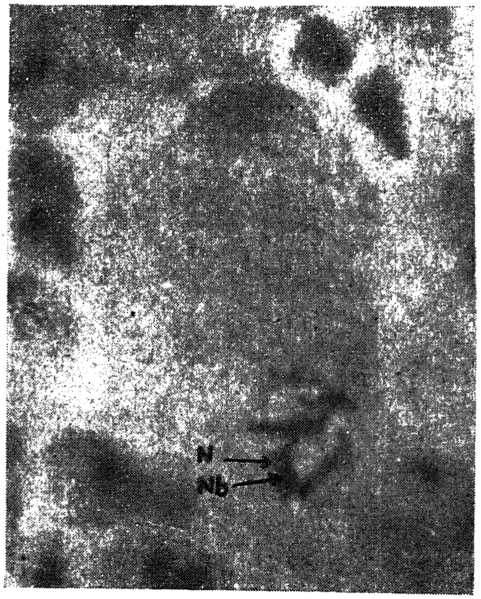

FIG. 1. First division of the diploid nucleus in ascus—(diplotene stage) showing N—Nucleolus; Nb—Nucleolur bivalent, × 1,160.

It may be noted here that Colson[1] reported the persistent nature of the nucleolus at both metaphase and telophase and found remnants of the diploid nucleus at telophase in *Phyllactinia corylea*. On the other hand, the nucleolus was found to degenerate in the early stages of the first division by its complete dissolution at metaphase of the same division in *P. yarwoodii*.

The diploid chromosome complement in *P. yarwoodii* was determined in these studies as 10 as against the widely variable number, *viz.*, $2n = 20$, 8 and 16 reported in *P. corylea* by Colson,[1] Eftimiu and Kharbush[2] and Heim[3] respectively.

Grateful thanks are due to Prof. M. N. Kamat for his guidance.

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M.A.C.S., Poona-4, *August* 23, 1968.
P. G. PATWARDHAN.

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GRAFTING BEHAVIOUR BETWEEN *GOSSYPIUM ARBOREUM* L. VAR. 231 R. AND *G. HIRSUTUM* L. VAR. H 14

GRAFTING prior to crossing as a means of overcoming interspecific crossability barrier in plants has been utilized by several workers.[1-5] Crosses between *Gossypium arboreum* and *G. hirustum* are incompatible and only a few workers have successfully reared the hybrids after making a large number of crosses. Since the crosses between *G. arboreum* and *G. hirsutum* would be valuable in improving the fibre properties of strains of *G. arboreum*, studies were carried out to utilize grafting as a means to overcome incompatibility barrier.

Reciprocal interspcific grafts were made using 6–7 weeks old seedlings in pots. The cleft grafting method was followed and grafted region was tied firmly with a thin alkathene tape. The tape was loosened about 15 days later, when the grafts were established. The data regarding total number of grafts made and percentage of success obtained are given in Table I.

TABLE I

Percentage of successful grafts between G. arboreum *and* G. hirsutum *(total of results of three different years)*

Combination		Number of grafts made	Number of grafts set	Percentage of settings
Stock	Scion			
G. hirsutum +	*G. arboreum*	147	105	71·4
G. arboreum +	*G. hirsutum*	149	27	18·1

It is clear from Table I that the percentage of grafts set was higher (71·4) when *G. hirsutum* was used as root stock. The grafts 'took' quickly in this combination. The growth of scion (*G. arboreum*) was normal and there was profuse flowering. Pollen fertility and seed set were normal.

The percentage of successful grafts was quite low (18·1%) when *G. arboreum* was used as the root stock. The growth of scion (*G. hirsutum*) was stunted and each plant bore only a few flowers. Pollen fertility was normal. Flowers when selfed showed normal seed setting. However, the size of the bolls was always smaller than with the ungrafted plants. These grafts could not be made to remain perennial.

Since these differences have been observed during three different years, it appears, that reciprocal differences exist in the extent of graft compatibility in the two species. The graft takes more readily when the tetraploid parent is the root stock. The progenies of scion did not reveal any hereditary effect of the stock on the scion.

There was marked increase in the percentage of furit-setting in the cross grafted-*G. arboreum* × *G. hirsutum* (23·7%) as compared to the normal cross (2·3%). This improved the possibility of successfully crossing the two species. Grafting did not induce any enhancement in the fruit-setting in the reciprocal cross, *i.e.*, grafted-*G. hirsutum* × *G. arboreum* over the cross *G. hirsutum* × *G. arboreum*.

Data on reciprocal grafts between diploid and tetraploid species are not available in the literature. Cell surface-volume relationship in relation to physiological processes like osmotic pressure, translocation, etc., assume importance. More detailed studies are needed to understand the cause of reciprocal differences.

I am grateful to Dr. M. S. Swaminathan, Director, I.A.R.I., for suggesting and guiding the present study.

Division of Genetics, O. P. GOVILA.
Indian Agricultural Research
Institute,
Delhi-12, *August* 20, 1968.

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A NOTE ON *PARATYLENCHUS MUTABILIS* COLBRAN[1] 1968 (NEMATODA: CRICONEMATIDAE) FROM INDIA

SEVERAL females, larvæ and five males of *Paratylenchus mutabilis* were collected from the roots of *Colocasia* sp. and *Coffea canephora* Pierre. during June 1967 at the Central Coffee Research Institute's estate. The measurements and a few important morphological characters are given below.

Obes Females (9).—$L = 354\,\mu$ (340–$370\,\mu$), $a = 8\cdot8$ ($8\cdot0$–$9\cdot3$), $b = 3\cdot6$ ($3\cdot2$–$4\cdot0$), $c = 14\cdot4$ ($13\cdot3$–$15\cdot4$), $V = 80\cdot1$ ($77\cdot7$–$81\cdot0$), P.E. $= 25\cdot0$ ($24\cdot3$–$29\cdot4$), stylet $= 54\cdot0\,\mu$ ($50\cdot0$–$55\cdot0$).

Males (5).—$L = 268\,\mu$ (260–$300\,\mu$), $a = 19\cdot8$ ($18\cdot0$–$21\cdot5$), $b = 4\cdot3$ ($3\cdot7$–$4\cdot7$), $c = 15\cdot6$ ($13\cdot3$–$18\cdot0$), P.E. $= 24\cdot2$ ($21\cdot4$–$27\cdot7$), spicule $= 16\,\mu$, gubernaculum $= 2\cdot5\,\mu$.

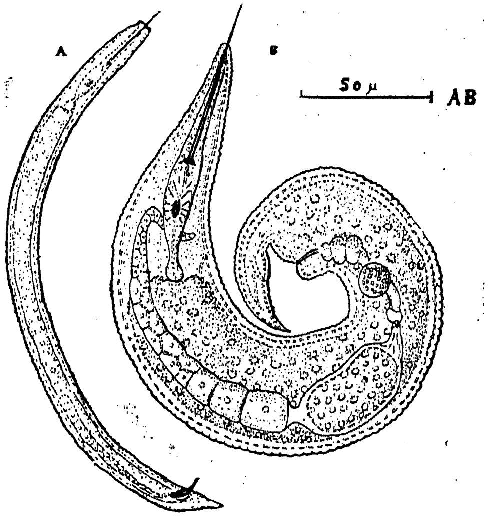

FIG. 1. *Paratylenchus mutabilis*. A. Male; B. Obes female.

The females are wider in body diameter and have longer stylet as compared with the type specimen (a = 12·1–15·2 and stylet length is 48·1 respectively). Colbran named this species *mutabilis* because the striæ and incisures (four in nos.) disappear at the swollen part of the body and the same was replaced by three bands of tubercles. This character is not noticed on the specimens under present study and all incisures continue to be present throughout.

Grateful acknowledgements are due to Dr. R. C. Colbran, Department of Primary Industries, Entomology Laboratory, Brisbane, Australia., and to Dr. E. Geraert, Laboratorium voor Morphologie, Instituut voor Dierkunde, Rijksuniversiteit Gent, Belgium, for their kind help in identification of the specimen.

Division of Entomology and Nematology,
Central Coffee Res. Institute,
Chickmagalur District,
Mysore State, *August* 31, 1968.

A. C. KUMAR.
G. I. D'SOUZA.

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HENDERSONIA DRACAENAE SP. NOV.

SPECIES of *Dracæna* are important ornamental plants grown for their variegated leaves. During July-August 1967, severe infection of leaf-spots, confined mostly to the leaf margins, was observed on a *Dracæna* sp. growing in the compound of the C.I.B.C. laboratory, Bangalore. Examination of the fructification revealed that a new species of *Hendersonia* Berk. was the causal agent. The fungus was obtained in pure culture. The species is described below:

Hendersonia dracaenae **Ponnappa Sp. Nov.** (Fig. 1).

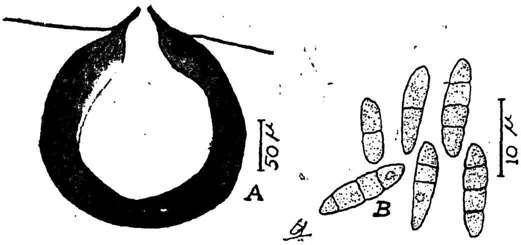


FIG. 1. *Hendersonia dracænæ*. A—Pycnidium; B—Spores.

Foliicolous, spots epiphyllous, brown, sparse, mostly along the margin of the leaf, oval or elliptical measuring up to 10 mm. in diameter. Pycnidia epiphyllous, few, solitary, subepidermal, innate-erumpent, globose or depressed-globose, brown to dark brown, pseudoparenchymatous, pycnidial wall up to 7·5 μ thick and dark-coloured, ostiolate, 92·25–194·50 × 92·25–243·0 (av. 144·0 × 194·5) μ; conidia mostly 3-septate, with occasional 1- or 2-septate forms, cylindrical, fusiform-elliptical or oblong-elliptical, slightly constricted at septa, pale brown to light brown, brown *en masse*, truncate to round at both ends, guttulate, 9·30–15·80 × 2·75–3·75 (av. 13·95 × 3·0) μ.

Habitat: On living leaves of *Dracæna* sp., August 28, 1967, Bangalore, Mysore State, K. M. Ponnappa. Pure culture of the fungus grown on steam-sterilized leaf of *Dracæna* in Herb. IMI 129822 (type).

Hendersonia dracaenae **Ponnappa Sp. Nov.**

Fungus foliicola, maculæ epiphyllæ, brunneæ, sparsæ, plerumque secus marginem folii, ovales vel ellipticæ, usque ad 10 mm. diametro. Pycnidia epiphylla, pauca, solitaria, subepidermalia, innata-erumpentia, globosa vel depressa-globosa, brunnea vel fusca, pseudoparenchymata, paries pycnidicus usque ad 7·5 μ crassus, fuscus, ostiolatus, 92·25–194·50 × 92·25–243·0 μ; conidia plerumque 3-septata interdum 1 vel 2-septatis formis, cylindracea, fusiformia-elliptica, leviter constricta ad septa, pallida vel ferruginea, brunnea in massa, truncata vel rotunda in ambis extremitatibus, guttulata, 9·30–15·80 × 2·75–3·75 μ.

Habitat in foliis viventibus *Dracæna* sp., August 28, 1967, Bangalore, Mysore State, K. M. Ponnappa, Herb. IMI 129822 typus.

Cultural characters: The fungus grows well on potato-dextrose agar, with light yellow fluffy aerial mycelium and yellowish-brown submerged mycelium. When the fungus was grown on steam-sterilized leaf bits in test-tubes at laboratory temperature of 18°–28° C. (ambient temperature 16–34° C.) numerous fructifications were produced after 12 days with scanty mycelium. The spores germinate readily on PDA and on tap-water and form stromatic mycelium within 3 days. Minute, black, solitary pycnidia appeared on PDA tubes after the 10th day.

The author is grateful to Dr. V. P. Rao, C.I.B.C., Indian Station, for his keen interest and permission to publish this paper, to Dr. E. Punithalingam, Commonwealth Mycological Institute, England, for identifying the fungus and to Mr. P. Basu for Latin diagnosis.

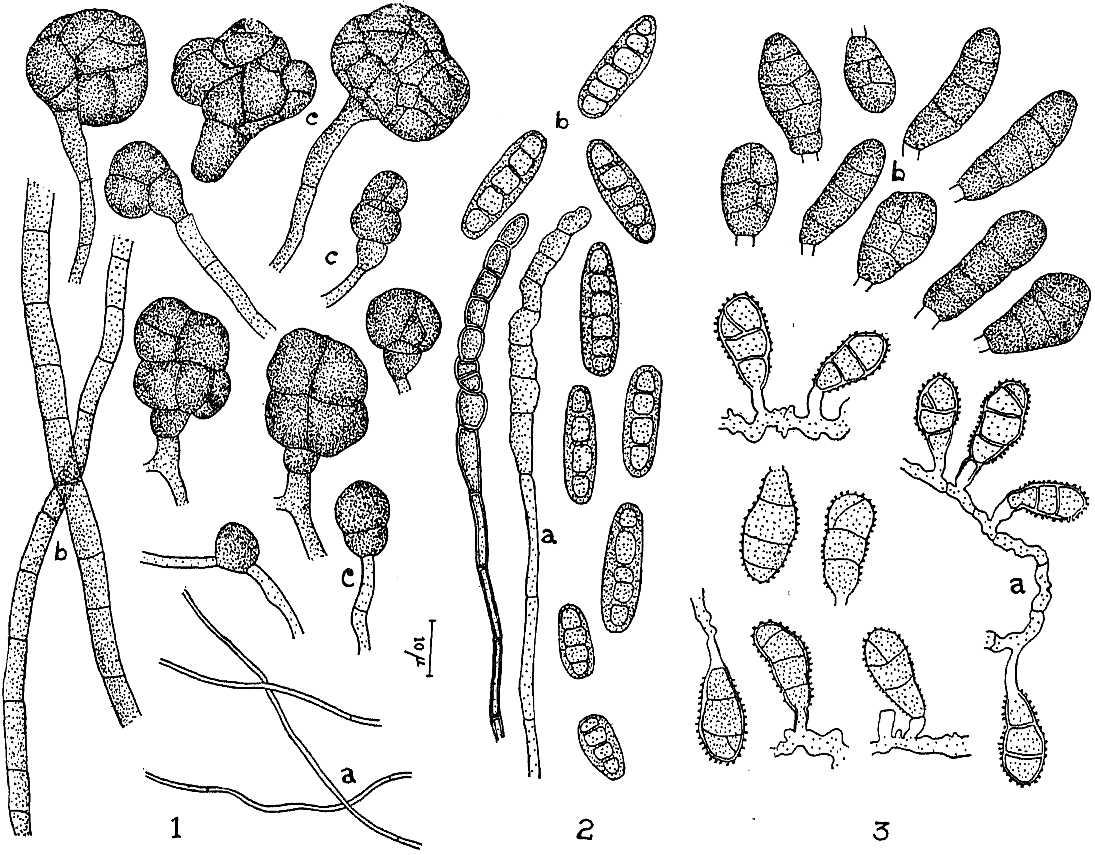
Commonwealth Inst. of Biological Control, Indian Station,
Bangalore-6 (India), *April* 12, 1968.

K. M. PONNAPPA.

THREE NEW RECORDS OF FUNGI FROM SOILS

During the course of studies of fungi occurring in soils of Andhra Pradesh, the authors have isolated *Acrospeira fluctuata*, *Helminthosporium hawaiiense* and *Pithomyces sacchari*, which have not been recorded from soil so far.[1]

Acrospeira fluctuata Tandon and Bilgrami in *Sci. & Cult.*, 1961, 27 : 407–08.



FIGS. 1–3. Fig. 1. *Acrospeira fluctuata*. *a*. thin hyaline ; *b*, thick brown hyphæ ; *c*. conidiophores and conidia. Fig. 2. *Helminthosporium hawaiiense*. *a*, conidiospores ; *b*, conidia. Fig. 3. *Pithomyces sacchari*. *a*, mycelium, conidiophores and young conidia ; *b*. mature conidia.

Colonies of the fungus growing well on potato sucrose agar, upto 5·0 cm. diameter in seven days, first light grey, becoming dark grey with age; mycelium composing of a network of thin hyaline and thick brown hyphæ; conidiophores both terminal and lateral, light brown, 5·2–8·0 μ in width, flattened end bearing conidia of very variable shape and size; conidia dark brown, 2–14-celled with straight or oblique septa. The size of the different types of conidia is as follows: 2-celled 12·8–14·4 × 7·2–11·2 μ (13·4 × 9·1 μ), 3-celled 9·6–16·0 × 8·0–14·4 μ (11·4 × 12·8 μ), 4-celled 14·4–17·6 × 6·4–8·0 μ (16·1 × 7·2 μ), 5-celled 16·0–22·4 × 8·0–9·6 μ (18·8 × 8·1 μ), 6-celled 22·4–25·6 × 6·4–9·6 μ (24·0 × 7·2 μ), 7-celled 16·0–27·2 × 8·0–16·8 μ (20·5 × 12·9 μ), 10-celled 16·0–32·0 × 8·0–25·6 μ (24·1 × 14·5 μ), 14-celled 25·6–36·8 × 8·0–16·0 μ (30·5 × 12·3 μ).

Isolated by the authors from soil supporting *Anacardium occidentale* L. at Sahibnagar, Hyderabad (28-2-1966, OUF-18).

Helminthosporium hawaiiense Bugnicourt in *Rev. gen. Bot.*, 1955, 62 : 238–43.

Colonies of the fungus spreading rapidly on potato sucrose agar, dark grey with abundant ærial mycelium; conidiophores simple, slightly geniculate, dark brown, septate, 42·2–175·2 ×

3·6–4·2 μ; conidia cylindrical, pale brown, 3–5 septate, 22·0–51·2 × 6·4–9·6 μ.

Isolated by the authors from coastal dune soil, Chirala, Guntur District (25-6-1963, OUF-19).

Pithomyces sacchari (Speg.) **M.B. Ellis** in *Mycol. Pap.*, 1900, 76: 17; Agnihothrudu, V., *J. Indian bot. Soc.*, 1962, 41: 478–490.

Colonies of the fungus growing slowly on Horne and Mitter's medium, upto 4·0 cm. diameter in weekdays, at first white, slowly turning olive-grey and finally to black; mycelium superficial, forming a network of branched, olive-brown, smooth, occasionally verruculose hyphæ, 2·5 μ in width; conidiophores borne laterally on the hyphæ, straight or curved, hyaline to subhyaline, 2·4–7·2 × 1·6–3·2 μ; conidia formed singly at the apex of conidiophore, variable in shape, oval to pyriform with 1–3 transverse septa and rarely with 1 or 2 vertical septa, pale brown when young, dark brown at maturity, smooth to verruculose, 12·0–25·0 × 4·0–12·8 μ, 12·8 μ at the broadest part.

Isolated by the authors from soil supporting *Eucalyptus* sp. at Sahibnagar, Hyderabad (28-9-1966, OUF-20).

The cultures are deposited in the Mycology and Plant Pathology Laboratory, Osmania University, Hyderabad.

The authors wish to express their grateful thanks to Dr. Ainsworth, Director, and Dr. M. B. Ellis, C.M.I., Kew, for their help in identification and to Prof. M. R. Suxena for kind encouragement. One of the authors (A. V. L.) is thankful to the Ministry of Education for the award of a Fellowship.

Botany Dept., A. V. Lakshminarasimham.
Osmania Univ., P. Rama Rao.
Hyderabad-7 (A.P.),
August 22, 1967.

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1. Gilman, J. C., *A Manual of Soil Fungi*, 2nd Ed., The Iowa State College Press, Ames., Iowa, U.S.A., 1957.

THE OCCURRENCE OF SEXUAL FORM OF *PENTALONIA NIGRONERVOSA* COQUEREL

Sexuales were hitherto unknown of *Pentalonia nigronervosa* Coquerel, the banana aphid which is common on *Musa* spp. in tropical and subtropical regions of the world. Hille Ris Lambers (1949) was doubtful about the occurrence of sexual forms of the species while Kolkaila and Soliman (1954) asserted that this species leads entirely an anholocyclic life-cycle.

While working with the aphids of Calcutta and suburbs, the apterous oviparous morph of *Pentalonia nigronervosa* Coq. was discovered from the leaf-sheath of *Curcuma longa* Linn. (Zingiberaceæ) [Locality: Rautara, 24-Parganas, West Bengal; 17-12-1967; coll. L. K. Ghosh]. The ant *Tetramorium* sp. was found attending this aphid. The apterous oviparous female is rather oval, about 1·12 mm. long and is characterised by its rostrum, which is much longer than that of apterous and alate viviparous female, reaching past the bases of siphunculi; cauda bearing 5 hairs; and swollen hind tibiæ having 46 and 49 more or less round pseudosensoria.

Zoological Survey of India, R. K. Bhanotar.
34, Chittaranjan Avenue, L. K. Ghosh.
Calcutta-12, *May* 23, 1968.

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1. Hille Ris Lambers, D., *Temminckia*, 1949, **8**, 220.
2. Kolkaila, A. M. and Soliman, A., *Bull. Soc. Fouad Ent.*, 1954, **38**, 231.

REVIEWS AND NOTICES OF BOOKS

Treatise on Collagen (Vol. 1). Edited by G. N. Ramachandran. (Academic Press, London and New York), 1967. Pp. xii + 556. Price 126 *sh.*

Treatise on Collagen (Vol. 2, Part A). Edited by G. N. Ramachandran and Bernard S. Gould. (Academic Press, London and New York), 1968. Pp. xvi + 434. Price 110 *sh.*

Treatise on Collagen (Vol. 2, Part B). Edited by G. N. Ramachandran and Bernard S. Gould. (Academic Press, London and New York), 1968. Pp. xv + 488. Price 120 *sh.*

This series of volumes provides an account of the field of collagen research in prospect and retrospect, particularly dealing with its more scientific aspects rather than its technical applications. The two basic volumes are Volume 1 "Chemistry of Collagen" and Volume 2 "Biology of Collagen". Volume 1 deals with amino-acid composition, amino-acid sequence, an account of the molecular structure at the atomic level, properties of soluble collagen and its general structure, the details of the molecular transformations in solution, subunits and special structural features of tropocollagen and an account of intact collagen as it is obtained from the tissues. There is a concluding chapter on synthetic polypeptide models for collagen.

Volume 2 is in two parts and deals with the basic biology of collagen; it is under the direct editorship of Dr. Bernard S. Gould of the Massachusetts Institute of Technology. The 13 chapters deal with different aspects of research on biology, biochemistry and biosynthesis of collagen including a discussion of these in relation to certain pathological conditions and of mineralization and ageing. Typical chapters describe the fibre forming cell, comparative biology and biochemistry of collagen, biosynthesis of collagen, collagen-mucopolysaccharide interactions, collagen vitamin interactions, immunology of collagen, collagen in bone formation and mineralization, and collagen in ageing.

The editors have attempted to make the treatment extensive, for those who are comparatively new to the subject, as well as intensive, so that the latest developments are discussed in particular detail for those specializing in each field. The books are intended not only for those who are working on different aspects of collagen research, but also for those interested in the applied fields of collagen technology and of collagen diseases. The general biochemist will find in these volumes an up-to-date account of the recent developments regarding this fascinating protein.

Subsequent volumes are planned to supplement these basic volumes: for example, Volume 3 will describe the chemical pathology of collagen.

The titles of the chapters contained in Volume 1 are: Composition of Collagen and Allied Proteins; Amino-Acid Sequences in Collagen; Structure of Collagen at the Molecular Level; Structure at the Electron Microscopic Level; Soluble Collagen and the Components Resulting from its Denaturation; Structure and Stabilization of the Collagen Molecule in Solution; Subunits and Special Structural Features of Tropocollagen; Intact Collagen; and Polypeptide Models for Collagen.

The titles of the chapters contained in Volume 2, Part A are: The Connective Tissue Fibre Forming Cell; Comparative Biology and Biochemistry of Collagen; Collagen Biosynthesis; Collagen-Glycosaminoglycan Interactions; Hydroxyproline and the Metabolism of Collagen; Mechanical Properties of Collagenous Tissues; Immunology of Collagen and Related Materials; The Role of Certain Vitamins in Collagen Formation; and The Effects of Hormones on Connective Tissue Cells.

The titles of the chapters contained in Volume 2, Part B are: The Morphogenesis of Collagen; The Organization and Structure of Bone, and the Mechanism of Calcification; Biological Mechanisms of Collagen Resorption; On Some Aspects of Collagen Formation in Localized Repair and in Diffuse Fibrotic Reactions to Injury; and The Role of Collagen in Aging.

C. V. R.

Wave Propagation in a Random Medium. By Lev A. Chernov. Translated from the Russian by R. A. Silverman. (Dover Publications, 180, Varick Street, New York-14, New York), 1968. Pp. viii + 169. Price $ 3.00.

This Dover edition, first published in 1967, is an unabridged republication with minor corrections of the English translation originally published in 1960 by the McGraw-Hill Book Company, Inc.

The first part of the book studies the problem of wave propagation using the ray approximation (statistical characteristics of the medium, ray statistics). Part II deals with the diffraction theory of wave propagation, the wave equation, scattering by inhomogeneities, fluctuations, correlation of fluctuations). Part III examines the question of how fluctuations in the incident wave affect the diffraction image formed by a focusing system (general formulas, the mean distribution near the focus, fluctuations behind the lens). Throughout the book, some theoretical deductions are compared with the experimental data, but the most involved calculations are relegated to appendices.

This book will be of interest to specialists in radiophysics and atmospheric acoustics and optics. C. V. R.

Books on Mathematics. (Published by Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1), 1968.

Ideas in Mathematics. By M. E. Munroe. Pp. 264. Price 59 *sh.*

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Basic Concepts of Mathematics and Logic. By M. C. Gemignani. Pp. 280. Price 75 *sh.*

This text is intended for a non-mathematician to appreciate the logic and thought processes involved in the study of mathematics. It presents many fundamental concepts of mathematics, but the main emphasis is on logic and the theory of sets.

Introduction to Mathematics for College Students. By K. C. Skeen and C. W. Wheeler. Pp. 424. Price 70 *sh.*

The title is misleading, at least for college students in India. A rapid perusal of contents and text shows that it is an elementary book, mostly arithmetic, for high school classes.

Sets, Functions and Probability. By J. B. Johnson, G. B. Price and P. S. Van Vleck. Pp. 376. Price 89 *sh.*

The book provides an introductory text for finite probability theory and some of its applications. As the theory of probability has also become now a tool for use in the biological, management, and social sciences, applications and exercises have been chosen from these branches. The book is self-contained in that the first four chapters are on Sets, Functions, and Computing methods which provide the basic ideas to understand probability theory.

Probability. By Leo Breiman. Pp. 425. Price 126 *sh.*

Based on lectures delivered to an introductory graduate course, the book is devoted to modern developments in mathematical probability theory. There are chapters on Conditional Probability, Conditional Expectation, Martingales, Stationary Processes and the Ergodic Theorem, Markov Chains, Local Limit and Central Limit Theorems, Gaussian Processes, Stochastic Processes, Invariance Theorems, and Diffusions. A. S. G.

Books Received

Manual of Field Geology. By R. R. Compton. (Wiley Eastern P. Ltd., J. 41, South Extension 1, New Delhi-3), 1968. Pp. x + 378. Price Rs. 11·50.

Research in Progress (Vol. I). *Physical Sciences (1958-66).* (Secretary, Inter University Board, Rouse Avenue, New Delhi), 1968. Pp. xvi + 429. Price Rs. 30·00.

Basic Television (Part I) *1967.* (Asia Publishing House, Calicut Street, Bombay-1), 1967. Pp. 136. Price Rs. 20·00.

Selected Papers on Desalination and Ocean Technology. Edited by S. N. Levine. (Dover Publications, 180, Varick Street, New York-14 N.Y.), 1968. Pp. x + 437. Price $ 4.00.

The Elements of Digital Computer Programming. By E. D. Reilly Jr. and F. D. Federighi (Holden Day, San Francisco), 1968. Pp. x + 222. Price $ 9.50.

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VARIATION IN THE CHEMICAL COMPOSITION OF INDIAN SAMPLES OF *CENTELLA ASIATICA*

P. S. RAO AND T. R. SESHADRI*

Department of Chemistry, University of Delhi, Delhi-7

IN a programme of investigation of Indian vegetable drugs there was need to analyse samples of *C. asiatica* obtained from various parts of our country.

Centella asiatica (*Hydrocotyle asiatica*) is commonly called Brahmi and Mandukaparni and is well known for its medicinal value[1]; it has therefore been studied by various workers[2-14]. Their results are summarised in Table I.

TABLE I

Chemical components of Centella asiatica *Urb.*

Sl. No.	Origin of the plant	Saponin (s)	Sapogenin (s)	Sugars from the saponin (s)	Other components	Ref.
1	Madagascar	Asiaticoside	Asiatic acid	Glucose, Rhamnose		4, 5, 6
2	,,	Madecassoside	Madecassic acid	Glucose, Rhamnose		11, 12
3	Ceylon	Centelloside	Centellic acid	Glucose, Fructose	(a) Centic acid (b) Centoic acid	7
4	India		Indocentoic acid			7
5	,,	(a) Brahmoside	Brahmic acid	Glucose, Rhamnose, Arabinose	(a) Isobrahmic acid	
		(b) Brahminoside	,,	,,	(b) Betulic acid	9, 15
		(c) Asiaticoside	Asiatic acid	Glucose, Rhamnose	(c) Stigmasterol	
6	,,	(a) Thankuniside	Thankunic acid	Glucose. Rhamnose	Asiatic acid	8, 14
		(b) Isothankuniside	Isothankunic acid			

Because of the divergence in the results which may be due to the place of origin of the material, to the different techniques involved in the isolation of the components or to the difference in varieties of the plant, we wished to investigate samples from various parts of India using the same method. The present communication deals with our results with samples collected from Hardwar, Dehradun, Jammu, Trivandrum, Madras, Hyderabad and Lucknow. The general method of extraction is as follows. The alcoholic extract was concentrated and diluted with water and extracted successively with light petroleum, ether, ethyl acetate and *n*-butanol. The final aqueous solution was tested for free sugars by paper chromatography.

The light petroleum extract on chromatography on alumina yielded varying amounts of wax, carotenoids and chlorophyll. The ether extract was found to contain flavonoids (positive magnesium-hydrochloric acid colour test) besides free sapogenins and chlorophyll. It was evaporated to dryness, the residue dissolved in minimum quantity of ethyl acetate and light petroleum ether gradually added to it. After the initial separation of a dark green gummy residue, the supernatant clear solution on treatment with excess of light petroleum gave an yellow solid which on TLC (silica gel; toluene: pyridine: acetic acid 10 : 1 : 1)[16] showed two bright yellow spots. Column chromatography of the mixture on silica gel yielded two yellow compounds identical with kæmpferol and quercetin. A third flavonoid having a lower R_f value but not identical with myricetin, was found to be present in the mother liquors after the separation of kæmpferol and quercetin. These flavonoids were present in all the samples examined.

The ethyl acetate extract was evaporated to dryness, the residue taken up in methanol and fractionated into the neutral and basic lead salts. The lead salts were decomposed with H_2S in alcoholic suspension when reddish-brown gummy solids were obtained. Both the fractions gave a positive test for the presence of flavonoids and a positive Molisch test. Repeated attempts to crystallise these fractions or to separate the mixture by paper chromatography in different solvents met with little success. On hydrolysis with 7% aqueous sulphuric acid, both the fractions gave quercetin and kæmpferol as aglycones and glucose and rhamnose as sugar components.

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* Paper presented at the 19th session of the Indian Pharmaceutical Congress held at Hyderabad, December, 1967.

The *n*-butanol extract was concentrated under reduced pressure. The residue was dissolved in methanol and the solution poured with stirring into excess of dry ether when a colourless solid separated. It was quickly filtered and dried in a vacuum desiccator. The pale brown powdery solid answered tests for saponins. The yields of the saponins from different samples are given in Table II.

TABLE II

Saponin content of the various samples of C. asiatica

Sample No.	Source		Saponin content % of air dry weight of plant
1	Hardwar	..	3·4
2	Dehradun	..	3·2
3	Jammu	..	8·0
4	Trivandrum	..	1·6
5	Madras	..	2·3
6	Hyderabad	..	1·1
7	Lucknow	.	2·2

The crude saponin mixtures were purified by repeated precipitation from a methanol solution by ether. After ascertaining the absence of free sugars in them, they were examined by TLC (silica gel; *n*-butanol; ethyl acetate: water, 4 : 1 : 5, upper phase Fig. 1). Saponin mixtures from sample numbers 1, 2, 3, 4, 6 behaved identically showing three spots with R_f values 0·26, 0·38 and 0·81 while samples 5 and 7 showed three strong spots with R_f 0·26, 0·38 and 0·58. Authentic samples of madecassoside (II) and asiaticoside (I) had R_f values 0·26 and 0·38 respectively. Brahminoside and Brahmoside based on the sapogenin brahmic acid (≡ madecassic acid[17]) had R_f values 0·26 and 0·58. The absence of brahmoside in samples 1, 2, 3, 4 and 6 is therefore at once discernible. Madecassoside (II) and brahminoside have the same R_f value but the latter contains arabinose. Hence a method of ascertaining the presence of the latter is to subject the mixture to acid hydrolysis and test the acid hydrolysate for the presence of arabinose.[18] Tested this way arabinose was found to be absent in the acid hydrolysates of the saponins from samples, 1, 2, 3, 4 and 6. Therefore, brahmoside and brahminoside were absent in these samples and they contain madecassoside

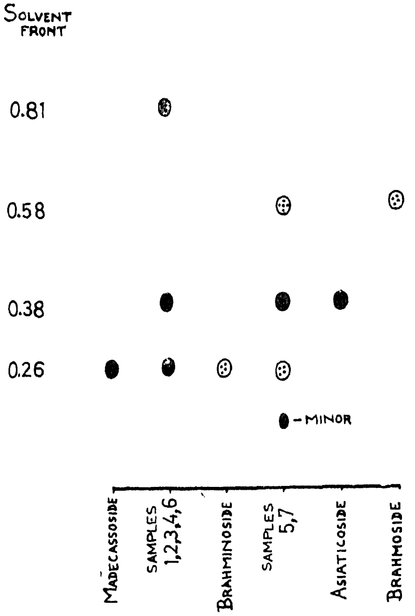
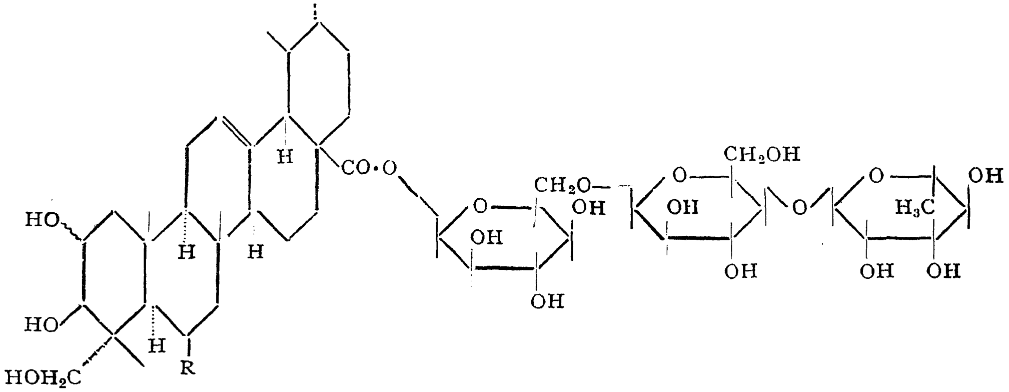


FIG. 1. TLC of saponin mixtures



I. Asiaticoside, R=H
II. Madecassoside, R=β-OH

and asiaticoside and a faster moving saponin. Arabinose was present in the samples 5 and 7 which contain brahmoside and brahminoside besides asiaticoside[14] as the saponin constituents.

Hydrolysis of the various saponin mixtures with alkali yielded madecassic and asiatic acids thus confirming that the saponins were of ester type. Acid hydrolysis of the saponin mixtures however gave besides the above, one more compound whose methyl ester agreed with the physical constants of anhydromethyl madecassate reported by Pinhas *et al.*[12] We could not however detect the presence of indocentoic acid,[7] thankuniside and isothankuniside[8] in our samples.

The above results indicate large variations in the yield of saponins depending on habitat; this is fairly common in plant drugs. The sample from Jammu was the richest. Considering the nature of the saponins there seems to be two varieties; the more common one contains asiaticoside and madecassoside whereas the less common one is characterised by the additional presence of arabinose in the saponins, thus forming brahmoside and brahminoside. The sapogenins are the same in both and similarly are the flavonoid components.

ACKNOWLEDGEMENTS

Our thanks are due to Dr. C. Dwarakanath for procuring various samples of plant material, Shri V. P. Mahajan, for a sample of material from Jammu area, Dr. H. Pinhas for samples of asiaticoside, madecassoside, methyl asiatate and methyl madecassate and for comparing our sapogenin methyl ester with methyl madecassate, Dr. R. P. Rastogi for samples of brahmoside, brahminoside and methyl brahmate, and the Indian Council of Medical Research for financial assistance.

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18. "Paper chromatography on Whatman No. 1 filter-paper; *n*-butanol : pyridine : water, 6 : 4 : 3; Aniline hydrogen phthalate spray."

RANGE OF STRUCTURAL AND ONTOGENETIC STOMATAL VARIATIONS IN THREE SPECIES OF *OCIMUM* (LABIATAE)

N. RAMAYYA AND V. JAGANNATHA RAO

Plant Anatomy and Taxonomy Laboratory, Department of Botany, Osmania University, Hyderabad-7, A.P.

THOUGH several workers[2-4,6] have reported structural and developmental variations of stomata occurring in the same species, none seem to have studied them for the entire stomatiferous area of the plants investigated. Importance of such an information needs no emphasis for, apart from giving an idea of the behaviour of a given plant part relating to its stomatal variations, it will enable to formulate criteria for utilising even the variable stomata for taxonomic purpose. Tognini, who was the first to describe organographic stomatal variations, based his conclusions from a study of comparatively larger number of plant parts (cotyledons, leaf, stipule, calyx, corolla and fruit; *See* in Gupta *et al.*[2]) than others;[2-4,6] even so he left from consideration quite a few parts as the hypocotyl, stem, bracts, peduncle, pedicel, floral disc, stamens, carpels and seedcoat all of which also usually possess stomata. The purpose of this paper is to bring to the fore the full extent of structural and developmental variations of stomata for the entire plant surface in *Ocimum adscendens*, Willd., *Ocimum basilicum* L. var. *pilosum* Benth., *Ocimum sanctum* Linn. (the usual cultivated form characterised by green stem), belonging to the family Labiatæ, the anatomy of which is being studied in this laboratory. The terms used are as defined by Pant[5] and Ramayya and Rao.[7]

The stomata observed are of two kinds the diacytic and anomocytic (Figs. 1 and 6). The diacytic are haplocyclic (Fig. 1 A) or at times amphicyclic (Fig. 5) or with only three subsidiaries (Figs. 1 M_1, M_2 & M_3). In two peelings, one from the stem of *O. basilicum* and another from the hypocotyl of *O. sanctum*, a paracytic stoma was also observed (Fig. 11).

The stomata are irregular in their distribution. They are mostly diacytic mixed with few anomocytic forms in the appendicular structures, *viz.*, cotyledon, leaf, bract and calyx in all the three species. They, however, differ in their structure on the cauline parts from one to the other species. They are mostly diacytic on the hypocotyl, stem and peduncle in *O. basilicum*, predominantly diacytic on the above parts in *O. adscendens* and mostly anomocytic in *O. sanctum.* The pedicel hardly bears a stoma or two in the three species and they are of the anomocytic type. The floral disc in all of them is unique in that all its stomata are anomocytic (Fig. 20), thus being absolutely different from the stomata of the leaf. On the disc, the stomata are confined to its distal margin on either side in *O. adscendens* and *O. basilicum*, whereas just restricted to its rim in *O. sanctum.* No stomata occur on the corolla, stamens, ovary, style and stigma nor on the seed as it is coalescent with the wall of the nutlet.

In each of the three species stomatal development has been studied on the hypocotyl, cotyledons, leaf, stem, peduncle, calyx and floral disc. It could not be followed on the pedicel in any of them due to the scarcity of the stomata ; on the floral disc of *O. sanctum* also the ontogeny was not studied as the stomata are borne on its rim and hence inconvenient to manipulate. Thus barring the above, the observations cover the entire stomatiferous area in the three species and hence suffice to get an idea of the patterns of stomatal development prevalent in them.

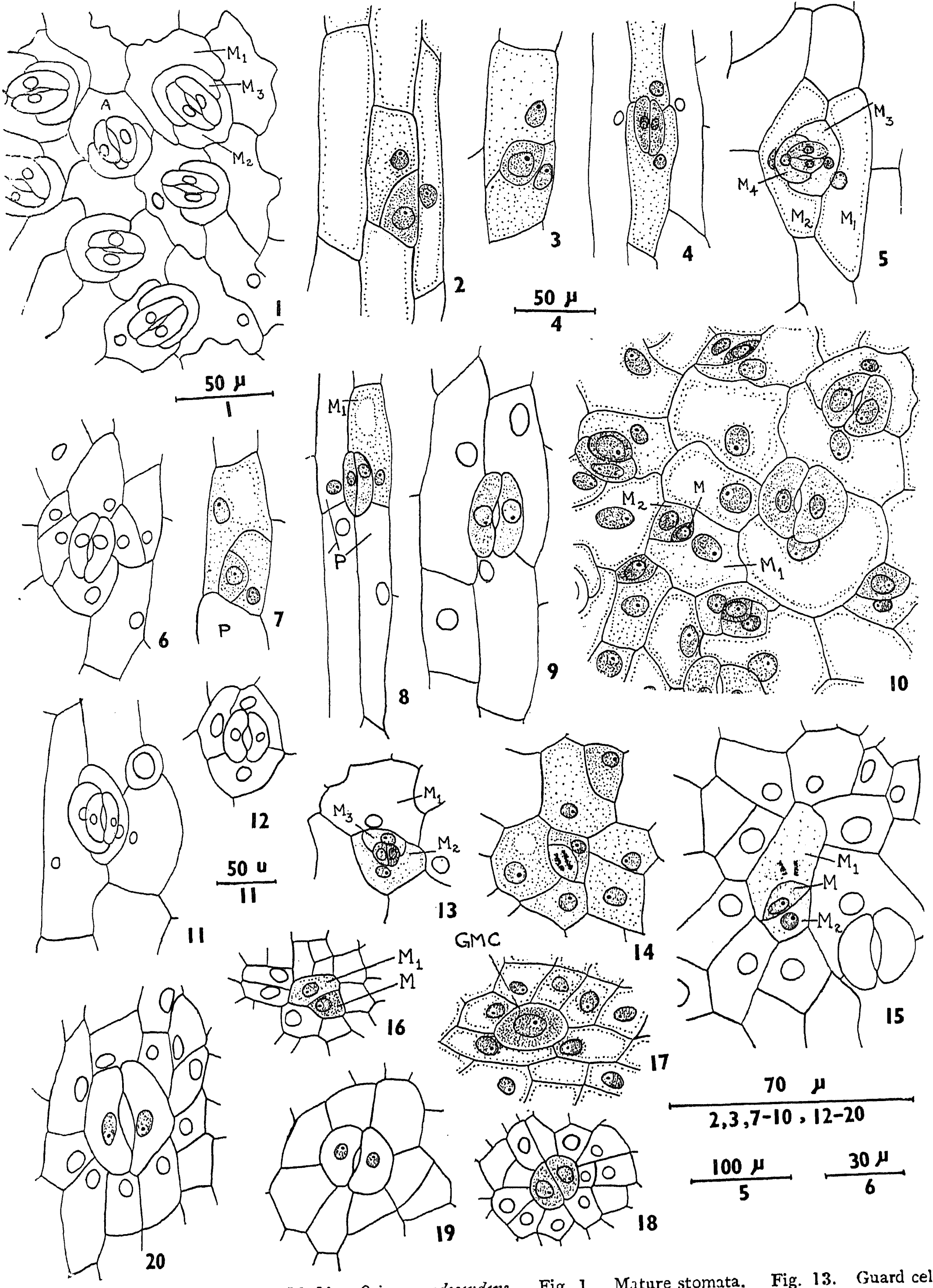
The development of the stomata is diffuse in all the parts studied and are derived from single protoderm initials. The diacytic stomata are dolabrate and mesogenous in developme wherever they occur in the three speci Their development as seen on the hypocot in *O. sanctum* and cotyledons and leaves *O. adscendens* is illustrated by the Figs. 2 and 10, 13. The diacytic stomata which ha two subsidiaries on the same side or whi are amphicyclic result from the meristemo cutting off twice on one or both of its fac respectively (Fig. 13).

The anomocytic stomata observed, howev show varied patterns of development. On t hypocotyl, they are usually unilabrate mes perigenous, with one or more subsidiaries perigenous origin (P). This happens becau of the meristemoid directly dividing into t guard cells after cutting the first subsidia (M 1) (Figs. 8 and 9). Rarely, the anom cytic stomata are dolabrate mesoperigenous their origin. This results from the no intersection of the partitions towards one the poles of the meristemoid (Fig. 7) whi allows the perigenous cell (P) lying on th side to remain in contact with the stoma.

The anomocytic stomata of the stem a peduncle and those occasionally seen on t leaf, cotyledons, leaves and calyx unlike th on the hypocotyl are dolabrate mesogeno thus resembling the diacytic stomata of t leaf and other parts in origin. Their anom cytic condition is due to secondary divisio in their mesogene subsidiaries (Figs. 15, 14, and 6).

The anomocytic stomata of the disc a however, peculiar in that their development quite in contrast with those occurring other parts. They are wholly perigenous, bei derived directly from the meristemoid. T first subsidiary, (M 1) so rapidly differentia into a normal epidermal cell that even befo the guard cell mother cell (GMC) has divid into guard cells, it is not recognisable (Figs. 1 20). This is comparable to the situati recently described in the Rubiaceæ[1] where t disc stomata are perigenous unlike the par cytic type of the other parts.

From the data collected it is clear th stomata are fairly stable in their structure a ontogeny on all the appendicular parts of t plant in the three species investigated. Th are mostly diacytic in structure and dolabra mesogenous in their development. Thou few anomocytic forms occur particularly mo on the cotyledons, they are also dolabra mesogenous in their ontogeny.



FIGS. 1-20. Figs. 1, 13, 16-20, *Ocimum adscendens.* Fig. 1. Mature stomata. Fig. 13. Guard cell mother cell just divided, both from leaf lower epidermis. Figs. 16-20. Development of anomocytic stomata from the disc abaxial surface. Figs. 2, 3, 6-9. *Ocimum sanctum.* Figs. 2, 3, 7-9. Developmental stages of stomata from the hypocotyl. Fig. 6. Anomocytic stomata from stem. Figs. 4, 5, 10-12, 14, 15. *Ocimum basilicum* var. *pilosum.* Fig. 4. Diacytic stomata from the hypocotyl. Fig. 5. Amphicyclic diacytic stomata from the stem. Figs. 10, 12, 14, 15. Developmental stages from the cotyledons. Fig. 11. Paracitic stomata from the stem. (M1, M2, M3 & M4 = Mesogenes of the diacytic stomata; M = Meristemoid · GMC = Guard cell mother cell; P = Perigene).

The stem and peduncle, though they have relatively more anomocytic forms unlike in the foliar appendages, in ontogeny, they too are dolabrate mesogenous like the diacytic forms.

The hypocotyl and floral disc, however, stand out from the other plant parts in regard to their stomatal structure and ontogeny. On the hypocotyl some of the anomocytic stomata are uni- or dolabrate mesoperigenous. On the floral disc, the stomata are further deviated, for all of them are anomocytic in structure and perigenous in origin.

From the above generalisations it is clear that stomata, despite differences in their structure, are stable regarding the origin of their subsidiaries on the different foliar appendages as well as the stem and peduncle. Thus the mode of origin of the subsidiaries of the stomata of the above parts suggests to be of taxonomic value in the three species studied. Further work would be of importance in showing upto what taxonomic level does this character remain constant in the family.

From the phylogenetic and morphogenetic viewpoint too, the occurrence of highly contrasting stomata confined to specific parts in the same plant is of significance. If perigenous stomata are regarded phyletically to have originated from the mesogenous ones through suppression of the meristematic capacity of their meristemoids as previously hypothesized by Pant,[5] the stomata of the floral disc represent derived forms. The immediate cause which may have brought about this modification is considered to be the localisation of hormones at a higher gradient in the floral disc which would inhibit meristematic activity; or it could be that the nectar in the disc acts as an inhibiting influence on the stomatal meristemoids.

ACKNOWLEDGEMENTS

The authors' gratitude is due to Prof. M. R. Suxena, Department of Botany, Osmania University, for keen interest and encouragement.

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OPEN SPIKELET—A RADIATION INDUCED MUTANT CHARACTER IN RICE

K. S. GILL, S. S. SAINI, MARY K. GEORGE AND H. S. KANDOLA

Department of Plant Breeding, Punjab Agricultural University, Ludhiana

THE note records the isolation of a new mutant character, open spikelet, in R_2 generation of a cross, *viz.* Jhona 349 × T(N)1 following irradiation of its seeds. The mutant is characterised by open spikelets in which the lemma and palea are unable to close after they have opened for blooming (Fig. 1); 80 to 85% of the spikelets remain sterile; and the remaining spikelets contain only partially developed kernels.

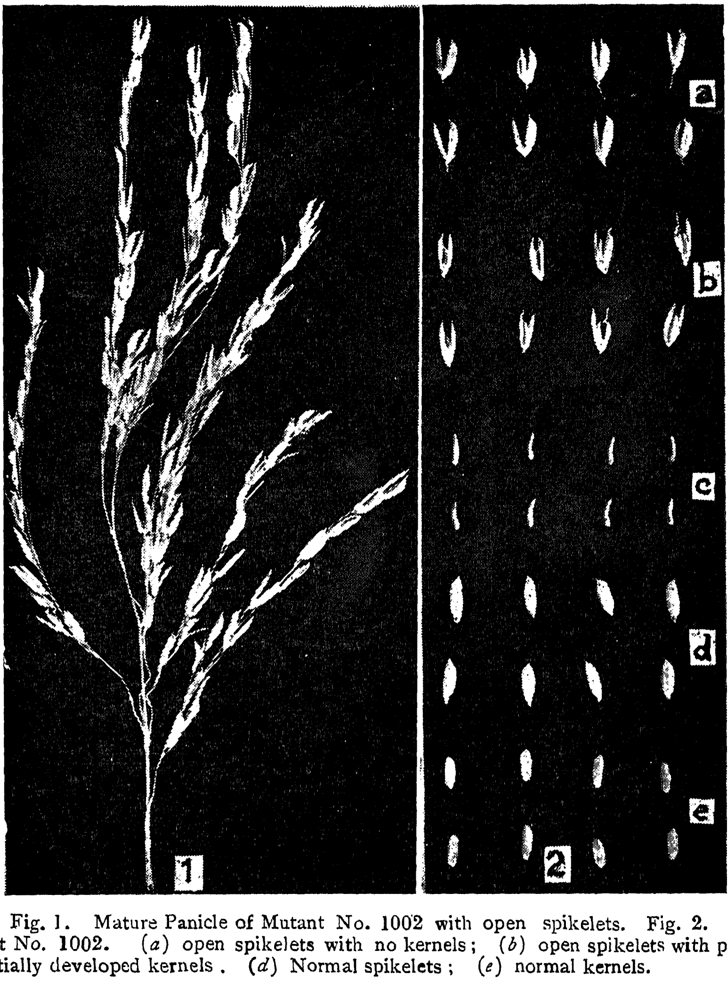
Five hundred dormant F_2 seeds of the cross were treated with 30 KR of gamma-rays from the Co^{60} source and were grown in R_1 generation during *kharif* 1966. Out of 500 seeds, 467 seeds germinated and seedlings grew to maturity. The main panicle in each plant was bagged just after heading to avoid natural crossing. On ripening the panicles were harvested and threshed individually. The seed from these panicles was grown in single separate rows in R_2 generation during *kharif* 1967. In progeny No. 10, two out of 8 plants had panicles in which spikelets remained open upto ripening. In one of these two plants some of the panicles were bagged immediately after heading. It was observed that all the spikelets in the selfed panicles remained open; majority of them were sterile; in few the kernels were partially developed. Similar condition was also observed in the remaining panicles of this plant, and those of the other plant.

The partially developed kernels collected from the selfed panicles were grown in R_3 generation during *kharif* 1968. This progeny, designated as Mutant No. 1002, bred true showing complete penetrance and expressivity of the mutant character. The main panicle of each plant was selfed, while others were left as such to mature. After harvest the spikelets of both the selfed and unselfed panicles from each plant were examined in the laboratory. It was observed that in the selfed panicles, two types of spikelets developed as on the mother plant in R_2 generation, *viz.*, open and sterile spikelets (Fig. 2 *a*), and open spikelets with partially developed kernels (Figs. 2 *b* and *c*). In unselfed panicles in addition to these two types of spikelets as observed in selfed ones there were a few spikelets which had fully developed kernels and looked like normal paddy grains (Figs. 2 *d* and *e*). The proportion of different types of spikelets in selfed and unselfed panicles is given in Table I.

TABLE I

Percentage of different types of spikelets in panicles of Mutant No. 1002 in R_3 *generation during* kharif *1968*

	Type of spikelets	Proportion of spikelets in percentage in	
		Selfed panicles	Unselfed panicles
1.	Open and sterile spikelets ..	85·14	80·33
2.	Open and with partially developed kernel	14·86	18·72
3.	Closed spikelets with fully developed kernel (Normal paddy grains)	..	0·95



FIGS 1–2. Fig. 1. Mature Panicle of Mutant No. 1002 with open spikelets. Fig. 2. Different types of spikelets of Mutant No. 1002. (*a*) open spikelets with no kernels; (*b*) open spikelets with partially developed kernels; (*c*) Partially developed kernels. (*d*) Normal spikelets; (*e*) normal kernels.

The data given in Table I show that:

1. Grain setting was more in the unselfed panicles than in the selfed ones;
2. Self-fertilization resulted in partial development of some of the kernels; and
3. Foreign pollen may cause development of the kernel into full grain and the spikelet to attain the size of normal paddy grain with closed lemma and pales.

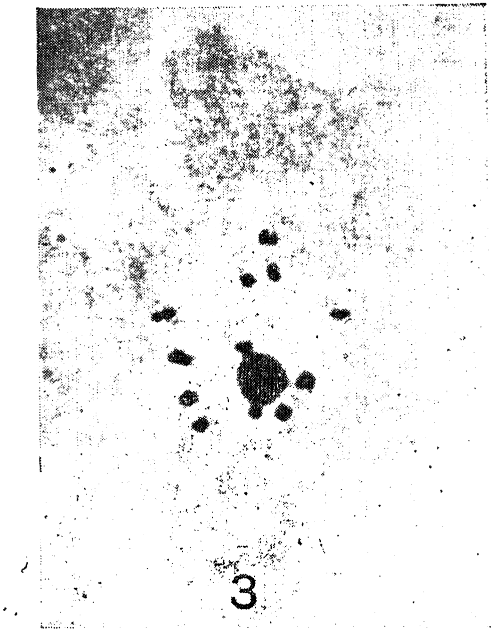


FIG. 3. Diakinesis exhibiting 12 bivalents in Mutant No. 1002.

These facts need further confirmation and progenies of partially and fully developed grains in the panicles of this mutant are being studied.

The open spikelet character in Mutant No. 1002, is assumed to be monogenic recessive because :

(1) It first appeared in F_2 generation;

(2) There were two mutant plants in a progeny of 8 plants, which is a very close fit to 3 : 1 ratio ; and

(3) The panicle row bred true in R_3 generation.

Meiosis was normal with 12 bivalents at diakinesis (Fig. 3) followed by regular metaphase and anaphase stages.

This new mutant seems to be promising, because firstly its open spikelets may help to effect larger number of crosses efficiently and it may help to exploit hybrid vigour of suitable cross combinations with different varieties. Studies in this direction have already been initiated at the Punjab Agricultural University.

INTERNATIONAL CONFERENCE ON SPECTROSCOPY*

THE volume contains the invited lectures delivered at the International Conference on Spectroscopy held in Bombay during January 9–18, 1967. The subject-matter is dealt with in five groups, *viz.*, I. Spectra of Atoms and Diatomic Molecules ; II. Electronic Spectra of Polyatomic Molecules ; III. Infrared and Raman Vibration-Rotation Spectra ; IV. NMR and Microwave Spectra and V. Solid State Spectra and General Topics.

Special mention has to be made here of two papers appearing in the volume, *viz.*, a paper by O. Theimer on the Raman effect in a plasma and another by J. R. Singer on Lasers with frequency shifting systems. In the former paper, light scattering by a plasma is interpreted as a Raman effect with longitudinal plasma waves and is described in a manner which clearly exhibits the close analogy between the Raman effect in plasmas and in crystals. The experimental difficulties associated with the high temperature, low density and the collective behaviour of a plasma are discussed and it is shown how one can determine the electron density and velocity distribution, the ion temperature and the amplitude of unstable plasma waves by means of the light scattering method.

The book is well got up and excellently printed by the Tata Press, Bombay. It will be of great interest to research workers in the field of Spectroscopy.

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* *International Conference on Spectroscopy* : Invited Talks, Bombay (Published for the International Council of Scientific Unions with the financial assistance of UNESCO by the Department of Atomic Energy, Government of India), 1968. Pp. x + 288. Price $12.50/ Rs. 75·00.

LETTERS TO THE EDITOR

MICROHARDNESS STUDIES ON TELLURIUM

ABSTRACT

Microhardness studies have been done on tellurium whiskers and cleaved surfaces of single crystals at low loads. In the plot of hardness *vs.* load, a peak at about 10 gm. load has been observed. This variation in hardness with load is explained in terms of the slip taking place due to deformation.

THE load variation of hardness of different materials has been studied by some investigators,[1–4] and the reported observations are somewhat contradictory. In view of this an attempt has been made to study the load variation of hardness at low loads for tellurium in the form of whiskers and cleaved surfaces of single crystals.

The microhardness measurements were carried out with a diamond pyramidal indenter supplied by M/s. Cook, Troughton and Simms, Ltd. which can be used with a Vicker's projection microscope. The diagonal lengths were measured with a micrometer eyepiece. In all cases the diagonal length used for calculating the Vicker's hardness was the mean of several measurements.

The whiskers of tellurium were obtained as follows: Some tellurium was placed inside a tube having an obtuse angle of about 120°. The source was kept at a constant temperature and the tube was continuously evacuated. At the cooler end of the tube a large number of whiskers were obtained having well-developed faces some 1 cm. in length and 0·5 mm. across. Before indenting, the whiskers were mounted on glass flats with one of the faces normal to the pyramidal indenter.

Single crystals were grown by the method of Chalmers in an atmosphere of hydrogen. The crystals were slowly cooled to liquid nitrogen temperature and then cleaved with a sharp knife-edge. The crystals were 0·5 cm.^{2} and 1 mm. thick. These were carefully mounted on glass flats before indenting.

The samples were indented with loads varying from 1 to 100 gm. and the Vicker's hardness was calculated. Figure 1 shows the variation of the hardness of the prismatic plane with load in the case of whiskers and cleaved crystals. From the graph it is seen that there is a peak at 10 gm. load for both the curves. On indenting above this load slip takes place. Tellurium has a hexagonal structure. The lattice consists of spiral chains, each spiral having three atoms per turn. The chains lie parallel to one another with corresponding atoms in each chain forming hexagonal nets. The bonds among atoms on the same chain are covalent, whereas between the chains they are a weak mixture of electronic and van der Walls binding. Because of the anisotropy of the atomic arrangement, the effect of the applied stresses causes the chains not to bunch together but to extend in length, slip occurring in the $(\bar{1}2\bar{1}0)$ directions. The shift in the curve of the whisker, or the higher hardness value at 10 gm. load in comparison with that of the cleaved surfaces is due to the high perfection of the whiskers. The initial increase in hardness may be due to the elastic recovery of the diagonal lengths. Once slip had started at 10 gm. load, the value in hardness decreases due to deformation by slip.

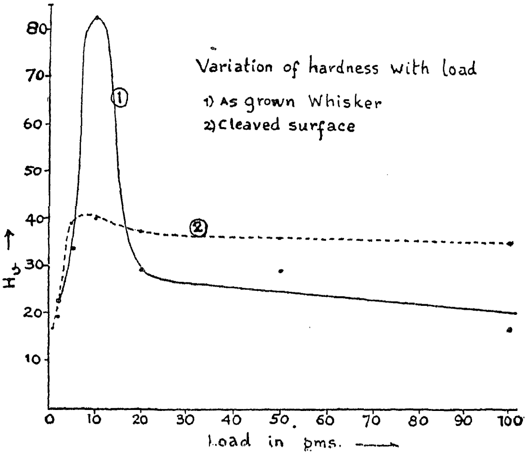

FIG. 1. A plot of Hardness *vs.* Load in the case of whiskers and cleaved surfaces.

The authors are grateful to Prof. N. S. Pandya for his encouragement, to the U.G.C for a Senior Research Fellowship to B.S.S. and to the M.S. University of Baroda for a Research Assistantship to E.M.

Physics Department, M.S. University of Baroda, Baroda, *September* 17, 1968.
B. S. SHAH.
ELIZABETH MATHAI.

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PAIR CROSS-SECTIONS OF GAMMA-RAYS IN THE ENERGY REGION 1 TO 2 MeV IN Cd AND Au

SYSTEMATIC studies were made in these laboratories by one of the authors[1] on the pair cross-sections of gamma-rays in the energy region 1 to 2 MeV and the results were compared with the theoretical calculation of Bethe and Heitler[2] and of Jaeger and Hulme.[3] The important conclusions drawn are that the values computed from the expressions of Bethe and Heitler are underestimates whereas those according to Jaeger and Hulme are overestimates. Recently, Hubbell and Berger[4] have made a critical examinaton of the available data on these cross-sections and reported a compilation incorporating various corrections. These calculations are based on Bethe Heitler's theory evaluated by Maximon[5] utilising screening corrections estimated by Sorenssen,[6] radiation correction of Mork-Olsen[7] and coulomb correction to Born approximation by empirical adjustments. To verify the accuracy of these values, experimental pair production cross-sections for gamma-rays in the energy region from 1 to 2 MeV have been measured in two typical elements Cd and Au.

The experimental arrangement, method and procedure are similar to those already reported.[1,8] The radioactive isotopes Sb^{124}, $\mathrm{Eu}^{152+154}$, Co^{60} and Sc^{46} were obtained from the Bhabha Atomic Research Centre, Bombay. The experiments were carried out with foils of Cd and Au. The cross-sections determined with the first three sources represent average pair cross-sections for all the pair producing gamma-rays emitted by the respective sources. Sc^{46} emits a single photon group (1·119 MeV) above the pair threshold. The corresponding theoretical cross-sections are obtained from the data of Hubbell and Berger[4] by interpolation. The error of interpolation in the case of gamma-rays from sources Sb^{124}, $\mathrm{Eu}^{152+154}$ and Co^{60} are not expected to exceed 5%. However, the values in the case of Sc^{46} may involve a larger uncertainty owing to the difficulty in interpolation very near to pair threshold.

The experimental cross-sections along with the theoretical values from Hubbell and Berger[4] and Bethe Heitler[2] are given in Table I. It can be seen that the values of Bethe Heitler are underestimations whereas those of Hubbell and Berger are in satisfactory agreement with the experimental values within the range of errors.

TABLE I

Pair cross-sections in barns per atom

Source		Au	Cd
Sb^{124}	Experimental	8·18	2·22
		±0·82	±0·22
	HB values	9·09	2·01
	BH values	5·3	1·96
$\mathrm{Eu}^{152+154}$	Experimental	0·38	0·11
		±0·04	±0·01
	HB values	0·36	0·12
	BH values	0·21	0·08
Co^{60}	Experimental	0·24	0·067
		±0·02	±0·007
	HB values	0·26	0·060
	BH values	0·12	0·044
Sc^{46}	Experimental	0·013	0·0050
		±0·001	±0·0005
	HB values	0·015	0·0060
	BH values	0·008	0·0020

HB : Hubbell and Berger   BH : Bethe and Heitler.

The Laboratories for Nuclear Research, Andhra University, Waltair, *October* 23, 1968.
J. RAMA RAO.
K. PARTHASARADHI.

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HIGH MULTIPLICITY ELECTRONIC TRANSITIONS IN THE SPECTRUM OF FeCl

THE spectrum of FeCl excited in a R.F. discharge from a 1/2 K.W. oscillator has disclosed the existence of a new system of red degraded bands designated as α in the region λ 3250-λ 3150. The bands appear to be double-headed when photographed in the first order of a 21 ft. concave grating spectrograph having a dispersion of 1·25 Å/mm. The vibrational analysis of the system suggests that it involves a $^4\Pi$-$^4\Sigma$ transition. The multiplet intervals between the corresponding heads in the sub-systems are unequal as in systems I and II of FeCl and found to be 12·7, 21·9, and 40·6 cm.$^{-1}$ The vibrational constants of the upper and lower states of the system given in Table I, do not correspond with any of the previously identified electronic states of the molecule.

The systems I and II of FeCl in the ultraviolet λ 3350-λ 3650 were previously analysed by Meischer,[1] Mesnage,[2] and Muller[3] and attributed to $^6\Pi$-$^6\Sigma$ and $^4\Pi$-$^4\Sigma$ transitions respectively. The bands of these two systems have been reexamined in the first order with the object of giving a complete multiplet analysis of the two systems.

The bands of $\Delta v = 0 \pm 1$ sequences of system I, revealed only P and Q heads. The absence of 'O' and 'N' heads indicates a tendency towards case 'c' in the upper $^6\Pi$ state.

The bands of $\Delta v = 0, \ -1$ sequence of system II revealed the presence of Q, P and 'O' heads. The presence of 'O' heads indicates that the coupling in the upper $^4\Pi$ state is intermediate between Hund's case '*a*' and '*b*'.

The vibrational constants of the upper and lower states of systems I and II are summarised in Table I. The vibrational constants of system II differ from those of Muller. The vibrational analyses of systems I and II have been well confirmed from a detailed study of the chlorine isotope effect in the $\Delta v \pm 1$ sequences.

TABLE I

	α system	System I	System II
ω_e'	415·6* cm.$^{-1}$	433·8 cm.$^{-1}$	428·0 cm.$^{-1}$
$x_e'\omega_e'$	...	1·70 ,,	1·56 ,,
ω_e''	427·3* cm.$^{-1}$	408·0 ,,	407·8 ,,
$x_e''\omega_e''$	...	1·58 ,,	2·96 ,,

* These values refer to $\omega_e - 2X_e\omega_e$.

Spectroscopy Labs., D. V. K. RAO.
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A MODEL FOR THE REYNOLDS STRESS IN TURBULENT SHEAR FLOWS

IT is now well known that a satisfactory prediction of turbulent shear flows cannot in general be made by any of the older theories relying on such local concepts as mixing length or eddy viscosity.[1] The rather elaborate methods that have been more recently devised are based either on further physical assumptions or on hypotheses on the turbulent energy balance.[2,3] The purpose of this note is to propose for the Reynolds stress a model equation which incorporates, in a phenomenological way, some of the essential characteristics of a turbulent shear flow. For simplicity we consider only two-dimensional flows in which the boundary layer approximations are valid; extension to more general flows will be relatively obvious.

Townsend and others[4,5] have emphasized the importance of the concepts of equilibrium and self-preservation to an understanding of the structure of turbulent shear flows. All experiments indicate that when the equations of motion admit a self-preserving solution, the actual turbulent flow ultimately corresponds to that solution. However, while real flows display a tendency towards such equilibrium whenever possible, the evolution takes place at a finite rate. This relaxation process is strikingly demonstrated in some experiments on turbulent wakes now being completed in our laboratory. These considerations suggest an equation for the stress τ of the type

$$\frac{d\tau}{dt} = \mathbf{A}\,(\bar{\tau} - \tau) \tag{1}$$

where d/dt is the time-derivative following the fluid, $\bar{\tau}$ is the stress at equilibrium (assuming that for the given local external conditions a corresponding equilibrium flow can be uniquely defined), and A is the reciprocal of a relaxation time which in general could depend on velocity, position and possibly also on τ. Equation (1) is the simplest model for relaxation; it can be considered as a first approximation for small departure from equilibrium, and can be easily refined further if experiments warrant it.

The equilibrium flow however does not represent a static situation as in thermodynamics; even when $\tau = \bar{\tau}$, $d\bar{\tau}/dt \neq 0$. In fact, examination of some simple flows suggests that the equilibrium flow is essentially a diffusive process. Thus, in the equilibrium wake, the stress $\bar{\tau}$ is given approximately by

$$\bar{\tau} \sim y x^{-3/2} \exp\left(\frac{-y^2}{4k'x}\right)$$

(where x and y are co-ordinates along and normal to the main flow), which is just the dipole solution to the diffusion equation

$$\frac{\partial \bar{\tau}}{\partial x} = k' \frac{\partial^2 \bar{\tau}}{\partial y^2}, \qquad (2)$$

with a constant diffusion coefficient k'.

The simplest model which describes both relaxation and diffusion is

$$\frac{d\tau}{dt} = \mathrm{A}\,(\bar{\tau} - \tau) + \frac{\partial}{\partial y}\left(k \frac{\partial \tau}{\partial y}\right), \qquad (3)$$

where we now allow for a diffusivity which in general may not be a constant.

Together with equations of conservation of mass and momentum, (3) provides a closed system. To a first approximation, the parameters k and A in (3) can be determined from data on the equilibrium flow and a relaxation experiment.

A rigorously exact equation for τ can of course be derived from the equations of motion, but it contains higher order correlations. Term-by-term modelling of this equation (along the lines adopted by Bradshaw *et al.*[3] for the *energy* equation) is of course possible, but this involves detailed assumptions which may be questionable in themselves, and are only valid to the extent that the general solutions are properly behaved. The present proposal has the advantage that it models the overall behaviour of the terms taken together rather than individually; the essential behaviour of shear flows is directly incorporated into the equations, without making specific assumptions about relations between the stresses and other mean quantities. Furthermore, at least for the simpler shear flows, the present system seems amenable to general analysis; a detailed application to non-equilibrium wake flows is now being made.

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REACTION BETWEEN SULPHUR TETRAFLUORIDE AND HYDROGEN IODIDE

THE chemistry of sulphur tetrafluoride has been the subject of intensive study ever since it was isolated and identified[1,2] in 1954. It was of interest to study its reaction towards hydrogen iodide as the latter has been employed in this laboratory to characterise a variety of sulphur compounds.[3,4] Preliminary studies indicated that the gas would readily get reduced to hydrogen sulphide and a corresponding amount of iodine liberated.

Pure sulphur tetrafluoride was prepared by the fluorination of sulphur dichloride with sodium fluoride in acetonitrile medium.[5] Traces of impurities such as chlorine, sulphur chlorofluoride and sulphur chloride were removed by shaking with mercury. The purified gas was collected over mercury and metered from a gas measuring burette.

A known volume of sulphur tetrafluoride (8–10 ml.) was allowed to react with a large excess (10–15 times) of anhydrous hydrogen iodide in a reaction vessel. A series of colour changes (orange-yellowish brown-violet) appeared immediately after the gases were allowed to come in contact with each other. The intensity of the colour deepened and finally the violet colour of iodine was prominent. When the reaction was complete (20–30 minutes), the products were analyzed in the following way. A stream of nitrogen was passed (30 mts.) through the vessel to sweep off the products through traps containing chilled carbon-tetrachloride (– 16° C.) followed by sodium hydroxide (4 N.) holding a cadmium hydroxide suspension. The carbon tetrachloride dissolved and retained iodine vapours present in the gaseous stream while hydrogen sulphide and hydrogen fluoride were absorbed by the alkali. Cadmium sulphide was separated by filtration and estimated iodometrically.

Fluorine was estimated in the filtrate by a modified method of Willard and Winter.[6] Iodine retained in carbon tetrachloride and in the raction vessel was extracted with an aqueous solution of potassium iodide (10%) and titrated against a standard solution of thiosulphate to determine the iodine content. Two representative experimental results (Table I) indicate that sulphur tetrafluoride is quantitatively reduced to hydrogen sulphide and corresponding amounts of hydrogen fluoride and iodine are liberated. The reaction may be visualised to take place in terms of the equation:

TABLE I

Reaction between sulphur tetrafluoride and anhydrous hydrogen iodide

Expt. No.	SF_4*	H_2S*	Iodine g. atom $\times 10^{-5}$	Fluorine g. atom $\times 10^{-5}$	I/H_2S	F/H_2S
1	37·16	36·98	223·3	148·0	6·04	4·01
2	48·95	48·70	292·6	189·4	6·01	3·89

* Concentration of sulphur tetrafluoride and hydrogen sulphide expressed in g. atoms of sulphur × 10^{-5}.

$$SF_4 + 6\,HI \rightarrow H_2S + 4\,HF + 3\,I_2.$$

It is probable that the reaction proceeds with the possible formation of intermediate compounds of sulphur and iodine (responsible for colour changes) which finally get reduced to hydrogen sulphide and a corresponding amount of iodine gets liberated.

Similar results were obtained when a solution of sulphur tetrafluoride in carbon tetrachloride[7] was treated with excess of anhydrous hydrogen iodide.

This reaction, therefore, can be adopted to estimate sulphur tetrafluoride.

Dept. of Inorganic (MRS.) D. K. PADMA.
and Phys. Chem., A. R. VASUDEVA MURTHY.
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THE TRITERPENES OF *RHABDIA LYCIOIDES* MART

IDENTIFICATION of bauerenol and α and β-amyrins in *Rhabdia lycioides* Mart (Syn.) *Rotula aquatica* Lour is described.

Rhabdia lycioides Mart (family Boraginaceæ) is well known for its therapeutic action. The plant was collected from the source of Kaliyarpuzha in North Travancore. After drying in the shade and removing the tiny leaves attached to the corky stem, the plant (4 kg.) was powdered and extracted with pet. ether (60–80°) in a Soxhlet apparatus. The crystalline residue obtained after removal of the solvent was crystallised from acetone to furnish a mixture of triterpene alcohols m.p. 210–13°. The mixture of alcohols (8·5 g.) was acetylated and the acetates refluxed with alcohol (300 ml.) to furnish two fractions, (*i*) Fraction A (4·5 g.) m.p. 275–80°, insoluble in ethanol and (*ii*) Fraction B (4·0 g.) m.p. 191–94° soluble in ethanol.

Fraction A after crystallisation from chloroform acetone was obtained as white flakes m.p. 282–84° $[\alpha]_D^{30} - 7°$ Found: C, 82·28; H, 11·31, $C_{32}H_{52}O_2$ requires C, 81·99; H, 11·18%) and was identified as bauerenyl acetate[1] by direct comparison (mixed m.p.; IR Spectrum) with an authentic sample kindly provided by Dr. P. Sengupta. Further support was provided by converting it to bauerenol and to bauerenyl benzoate and identified by direct comparison. Bauerenol is oxidised by chromic acid to bauerenone m.p. 32–33°. $[\alpha]_D^{30} - 48°$ (Found: C, 84·94; H, 11·62, $C_{30}H_{48}O$ requires C, 84·89; H, 11·32%) Bauerenyl acetate was just warmed to dissolve in acetic acid containing a few drops of sulphuric acid and kept at room temperature for 15 minutes. Iso-bauerenyl acetate[2] separated out as colourless needles m.p. 222–23° $[\alpha]_D^{30} + 38°$. It was also obtained by passing dry HCl gas for two hours through a cold solution of bauerenyl acetate in chloroform. Alkaline hydrolysis furnished iso-bauerenol[3] m.p. 175–76° $[\alpha]_D^{30} + 45°$.

Fraction B after repeated crystallisations furnished α-amyrin acetate and β-amyrin acetate identified through direct comparison (mixed m.p.; IR Spectrum and TLC behaviour) with authentic samples. The mixture of α- and β-amyrin was effectively separated through their benzoates by fractional crystallisation following the method of Musgrave and Wagner.[4] Both the components and their derivatives analysed satisfactorily.

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Dept. of Chemistry, MRS. P. SARADAMMA.
University of Kerala,
Trivandrum-1,
and
National Chemical A. S. RAO.
Laboratory,
Poona-8, *October* 9, 1968.

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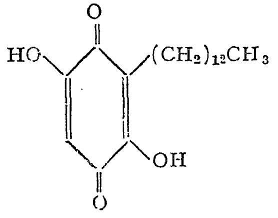
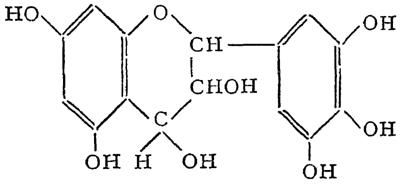
CHEMICAL EXAMINATION OF THE BERRIES AND FLOWERS OF *ARDISIA MACROCARPA* WALL

THE previous publication[1] reported the occurrence of rapanone (I) and (−) 3, 4, 5, 7, 3′, 4′, 5′-heptahydroxy-flavan (II) as the constituents from the bark and hardwood of *Ardisia macrocarpa*. We now report the chemical constituents of the berries and the flowers of *A. macrocarpa*.



(I)



(II)

Extraction of the berries with benzene gave lustrous orange plates and prisms (I), m.p. 140–41° C. (0·15%) which gave a diacetate, m.p. 64–66° C. and an acetate of its reduction product, m.p. 117–18° C. identical with rapanone and its derivatives.

The flowers of *Ardisia macrocarpa* were first extracted with pet. ether to remove waxy impurities and subsequent extraction with acetone gave a colourless product (II) as small prisms, m.p. 300° (d), from acetone, giving a heptaacetate, m.p. 228–30° C., a pentamethyl ether as colourless prisms, m.p. 184–85° C. from benzene and a diacetate of the pentamethyl ether as colourless prisms. m.p. 208–10° C. from benzene identical with (−) 3, 4, 5, 7, 3′, 4′, 5′-heptahydroxy-flavan (II) and its derivatives. It is interesting to note that products I and II present in the bark and the hardwood, are distributed in the berries and the flowers respectively.

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Dept. of Chemistry, V. K. MURTY.
Engineering College, K. R. PRABHU.
Andhra University, V. VENKATESWARLU.
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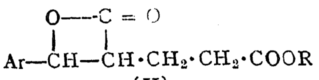
STOBBE CONDENSATION OF ALDEHYDES AND GLUTARIC ESTERS

GLUTARIC esters have been reported earlier not to undergo the Stobbe condensation.[1] Johnson *et al.*[1] obtained a low yield (10%) of Stobbe product from ditert. butyl glutarate under specific conditions. Puterbaugh[2] using the stability of lithium aldols has condensed ketones with ditert. butyl glutarate. Chatterjee and Banerjee have effected a Stobbe reaction with a suitably substituted indanone and dimethyl glutarate.[3]

It was observed that in the presence of potassium tert. butoxide the Stobbe condensation of glutaric esters and aromatic aldehydes was a facile reaction. Good yields of oily half esters (I *a*) were obtained which on hydrolysis yielded the α-arylidene glutaric acids (I *b*); with 3, 4-dimethoxy benzaldehyde a crystalline half ester (I *a*) was isolated. I.R. Spectrum of this half ester (on comparison with the I.R. Spectra of authentic samples of 3, 4-dimethoxy cinnamic acid and the corresponding ester), clearly showed an α, β-unsaturated acid and a free ester group (1680 cm.$^{-1}$ and 1727 cm.$^{-1}$ respectively). This leads to the structure of the half ester as I*a* (Ar = 3, 4-dimethoxy phenyl). Thus it is evident that this reaction proceeds *via* a β-lactone intermediate (II) and not a δ-lactone system.[1]

$$\mathrm{Ar{-}CH = C\,(COOH)\,CH_2{\cdot}CH_2{\cdot}COOR}$$

(I)



$$\mathrm{Ar{-}\overset{O-\!-}{C}H{-}\overset{C=O}{C}H{\cdot}CH_2{\cdot}CH_2{\cdot}COOR}$$

(II)

(*a*) R = Me or Et
(*b*) R = H

The reaction was, however, not successful when adipates or ketones were employed.

EXPERIMENTAL

A solution of dimethyl glutarate (4·0 g.) and 3, 4-dimethoxy benzaldehyde (4·15 g.) in tert. butanol (15 ml.) was added with stirring to potassium tert. butoxide (from 1 g. of potassium and 30 ml. of anhydrous tert. butanol) under an inert atmosphere. The reaction mixture was allowed to stand overnight at room temperature and then acidified with HCl (5 ml. of conc. HCl in 35 ml. of water) in cold. Most of the tert. butanol was distilled under reduced pressure and the residue was taken up in ether. The etherial solution was extracted with sodium bi-carbonate at 0°, the alkaline phase washed with ether and acidified. The precipitated oily half ester (5·8 g.) on fractional crystallization from benzene yielded *methyl γ-carboxy-γ-(3, 4-dimethoxy benzylidene) butyrate* (1·2 g.), m.p. 106–7°, found: eq. wt. 294·1; C, 60·8; H, 6·14. $C_{15}H_{18}O_6$ requires eq. wt. 294·2; C, 61·2; H, 6·12%. I.R. Spectrum, 5·78 μ (ester carbonyl), 5·95 μ (α, β-unsaturated acid). Alkaline hydrolysis of the oily product yielded γ-carboxy-γ-(3, 4-dimethoxy benzylidene) butyric acid (I *b*) (3·9 g.), crystals from aqueous alcohol, m.p. 192–94°, found: eq. wt. 139·2; C, 59·6; H, 5·64. $C_{14}H_{16}O_6$ requires eq. wt. 140·1; C, 59·9; H, 5·7%. I.R. Spectrum, 5·8 μ (α, β-unsaturated acid). A small quantity (0·6 g.) of 3, 4-dimethoxy benzoic acid, m.p. 180°, was also obtained from the reaction mixture.

Similarly the corresponding arylidene glutaric acids were prepared with benzaldehyde, anisaldehyde, piperonal, *o*-methoxy benzaldehyde, and *m*-chlorobenzaldehyde.

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Department of Chemistry, K. RAGHAVA RAO.
Nagpur University, G. BAGAVANT.
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AN EXPEDIENT FOR OVERCOMING THE INFLUENCE OF TEMPERATURE ON THE PHOTOMETRIC DETERMINATION OF SILICON IN FERROUS MATERIALS

IT is well known that temperature has a distinct influence on the colour intensities that are met with in the estimation of silicon.[1–6] Recent investigations[7,8] from our laboratories have shown that the influence of temperature on the colour intensities involved with pure silicate solutions in different procedures could be successfully overcome by using ascorbic acid as reducing agent. However, when this reductant was employed[9] in the colorimetric determination of silicon in cast iron, a definite increase in the colour intensities was noticed at higher temperatures. The use of a 3% ascorbic acid solution containing 0·1% stannous chloride controlled the influence of temperature to a significant extent.

Extending the investigations to the photometric determination of silicon in ferrous materials (*See* Ref. 2, BISRA methods), it was found that this temperature influence could be overcome by employing ascorbic acid in place of stannous chloride.[10] But ascorbic acid results in lower colour intensities, about three-fourths, compared with stannous chloride. Since the latter is the most sensitive of all the reducing agents used in this field, it was considered desirable to explore the possibilities of using it, even in the tropics, by making some modifications in the procedure. It is not always very easy to provide air-conditioning facilities for maintaining lower temperatures in the works laboratories, particularly in developing countries. Also thermostating photometric cells, etc., is not easy. It, therefore, suggests itself as a possible expedient that the above difficulty may be overcome by quickly raising the temperature of the solution just before measurement to the prevailing room temperature. To examine this aspect, solutions with varying silicon contents were

TABLE I

Silicon content (μg.)	Drum difference									
	Development of the colour and measurement done at						Development of the colour done at 20 ± 1° C. and measurement at			
	20 ± 1° C.		35 ± 1° C.		45 ± 1° C.		35 ± 1° C.		45 ± 1° C.	
	15 mts.	60 mts.	15 mts.	60 mts.	15 mts.	60 mts.	15 mts.	60 mts.	15 mts.	60 mts.
600	1·190	1·185	1·175	1·050	1·150	0·975	1·183	1·185	1·183	1·182
400	0·800	0·795	0·790	0·700	0·765	0·622	0·798	0·795	0·793	0·792
300	0·590	0·585	0·585	0·512	0·562	0·444	0·588	0·585	0·588	0·583
200	0·398	0·395	0·395	0·348	0·378	0·300	0·398	0·395	0·398	0·394
100	0·198	0·196	0·195	0·168	0·187	0·148	0·198	0·196	0·198	0·195
40	0·080	0·080	0·080	0·072	0·078	0·062	0·080	0·080	0·080	0·080

taken, the colour and blank solutions developed at 20 ± 1° C., then raised the temperature of a requisite amount of the solution (by immersing it in a 60° water-bath) to a temperature of 35 ± 1° C. or 45 ± 1° C. and immediately measured the colour intensities. The results so obtained along with the values obtained when both the development and colour measurements were done at the same temperature are presented in Table I.

An examination of the results shows that practically there is no influence of temperature on the colour intensities involved on taking recourse to the above expedient and hence it commends itself for adoption.

The author's sincere thanks are due to Dr. G. V. L. N. Murty, Chief Chemist, for his keen interest and valuable guidance and the Management of Tata Iron and Steel Co. Ltd. for permitting the publication of this note.

Research and Control Laboratories,
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Jamshedpur-7, *May* 18, 1968.
K. S. R. KRISHNAIAH.

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AMINO-ACID PRODUCTION BY SOIL MICROORGANISMS

A NUMBER of amino-acids which are nutritionally important occur in limiting ocncentrations in proteins of vegetable origin.[1] This makes it imperative to device economic methods for their production for food fortification. Already, the microbial world had offered promise for such a process when Kinoshita *et al.*[2] established a fermentation process for the production of glutamic acid using *Micrococcus glutamicus* and lysine using a mutant of this organism. Since then a wide variety of organisms have been shown to be capable of excreting in detectable amounts a number of amino-acids.[3] The present report deals with such a study with soil bacteria.

Using the serial dilution and selective culture techniques a total of 73 isolates were obtained from 7 garden soil samples. These were screened for amino-acid producers using the technique of Verbina[4] which employs a filter-paper disc to absorb amino-acids and a ninhydrin colour reaction to detect their presence. Only 12 of the 73 isolates showed this property. The amino-acids produced by each of the isolates were identified by chromatographing 20 μl of the culture fluid on Whatman paper No. 1, running the ascending chromatogram in butanol : acetic acid : water (4 : 1 : 1) system for 24 hr., developing the chromatograms with ninhydrin (0·5% in 75% acetone) and comparing the R_f values with those of standard amino-acids. Thus of the 12 isolates, 4 excreted alanine, 1 lysine and aspartic acid, 2 proline and aspartic acid, 3 glutamic acid, 1 excreted glycine and serine along with glutamic acid while 1 produced leucine and isoleucine. The best variety producing each of these amino-acids was identified on the basis of morphological, cultural and biochemical characteristics according to the methods described in *Bergey's Manual of Determinative Bacteriology*.[5]

Thus, on a minimal basal medium based on that of Ayers *et al.*[6] containing 5% glucose, a *Bacillus megaterium* species excreted glutamic acid (5·0 μg./ml.); *Bacillus firmus* species leucine and isoleucine (0·8 μg./ml.); *Becillus brevis* species proline and aspartic acid (2·5 μg./ml. each); a *Brevibacterium imperiale* species excreted lysine (6·0 μg./ml.) and a *Micrococcus freudenreichii* species excreted alanine (3·0 μg./ml.).

These studies are extended to microorganisms associated with soil samples obtained from oil-bearing areas with a view to locating microorganisms excreting amino-acids utilising conventional carbohydrates or petroleum hydrocarbons as energy source for growth. From three soil samples* (obtained within 50 meters from a productive oil well) 124 bacterial isolates, 33 fungi and 118 actinomycetes isolates were obtained by the serial dilution technique. Analysis of the bacterial isolates for amino-acid elaboration property as well as hydrocarbon utilization gave the following results.

(1) Amino-acid excreting using carbohydrate—40 isolates. (2) Amino-acid excreting using hydrocarbons—13 isolates. (3) Amino-acid non-excreting but using hydrocarbons—29 isolates.

The hydrocarbon source used was a mixture of kerosene : diesel oil (2 : 1) with 7·5% paraffin wax. Amongst the microbial isolates obtained in these studies, 11 are showing characteristic antagonistic properties.

Dept. of Chemical Technology,
University of Bombay,
Matunga Road, Bombay-19,
October 9, 1968.

K. KASTURI.
D. V. TAMHANE.

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* Obtained through the courtesy of Shri S. N. Talukdar, Assistant Director Geology, Oil and Natural Gas Commission, Dehradun.

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A NOTE ON THE LOSS OF FOOD TO THE LESSER BANDICOOT RAT, *BANDICOTA BENGALENSIS*

THERE have been several studies of food consumption of the Lesser Bandicoot Rat, *Bandicota bengalensis*. Deoras[1] reported the consumption to be 12·8 g./rat/day, while Spillett[2] reported it as about 11 g./rat/day. My data based on 34-adult rats (average body weight = 216·7 g.) for 20 days showed a somewhat higher average of 14·9 g./rat/day. All three of these reports were on animals housed in small cages.

The studies mentioned above were made in order to determine the amount of food actually eaten per day and they do not consider the bandicoot's highly developed tendency to hoard food. Although rat burrows are sometimes excavated by humans to retrieve the grain, almost all of the hoarded food is lost to humans and much, if not most, is also lost to the rats, since it often rots in the burrow. In order to determine the amount of food bandicoots would remove from a limitless supply, adult rats were introduced into a pen (4 × 6 meters) which contained unlimited sources of rice, wheat, and *dal* (*Lens culinaris*). During the first 15 days of the study 8 animals (4 males, 4 females) were used. The number of animals was reduced to 7 during the last 6 days, one male having died as a result of fighting. The rats were weighed at the beginning, middle, and end of the study and had average weight of 164·5 g. The dirt floor of the pen allowed for normal burrowing. The results are summarized in Table I.

TABLE I

Amount of food removed by Bandicota bengalensis *from unlimited supplies during 21 days*

Rice (g.)	Wheat (g.)	*Dal* (g.)	Total	No. rat days	$\bar{x}$ daily removal (g.)
3,525·2	4,069·6	3,330·3	10,015·1	162	67·4 g./rat/day

These figures have not been corrected for changes in the weight of the food brought about by changes in humidity. Calculation of the amount of food removed was based on the weight of the food remaining in the dishes after having been exposed during the humid night. Since the food in the dishes had probably gained weight during the night, the morning weights of the remaining food were probably somewhat high. This means that our figures of 67·4 g./rat/day may be somewhat low.

The average of the daily consumptions of caged rats mentioned earlier in about 13 g./rat/day. If this is taken to be a reliable estimate of actual food consumption, each animal on the "unlimited" food supply of the present study was daily removing approximately 67 g., eating 13 g., and hoarding 54 g. The rats were hoarding about 5 times the amount that they were eating. This means that in godowns where the amount of food is often "limitless" as far as the bandicoots are concerned, the actual loss to these animals is 5 times greater than the consumption. This is a factor which should be considered in estimating the total loss of food to bandicoots, since most previous estimates have been based on the rats' actual consumption and have ignored hoarding which is the major cause of food loss.

The Johns Hopkins University,
Center for Medical Research & Training,
4-A, Orient Row,
Calcutta-17, *October* 22, 1968.

DWAIN W. PARRACK.

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DETERMINATION OF MAGNESIUM—HIGH MAGNESIUM CONTENT OF ARABIAN SEA-WATERS

R. VISWANATHAN *et al.*[1] have employed Atomic Absorption Spectrophotometric methods for the determination of some cations in Arabian Sea-waters and have reported ion/chlorinity ratios for these elements. From the reported values, it is seen that magnesium/chlorinity ratio for this region is high, indicating the high magnesium content of Arabian Sea-waters. In the present investigation a few samples from the same cruise (I.N.S. "Kistna" cruise no. xxv of International Indian Ocean Expedition) were analysed for magnesium by titrimetry using EDTA to confirm the high magnesium content of this region.

Calcium and Magnesium determination in sea-water with (ethylenedinitrilo)—tetraacetic acid titration has been reported previously by DeSousa,[2] Pate and Robinson[3,4] and Szabo.[5] Szabo's method was first to determine calcium, magnesium and strontium together and then to determine only calcium and strontium after precipitating magnesium as $Mg(OH)_2$. In the second determination special precautions had to be taken because the observation of colour change at the end-point was difficult in presence of $Mg(OH)_2$ precipitates and calcium also co-precipitates with $Mg(OH)_2$. In the present method, the total concentration of magnesium, calcium and strontium is first determined and then the concentration of calcium and strontium is determined after precipitation as oxalate. The magnesium content is calculated from the difference of these determinations.

Reagents.—All chemicals used were of analytical grade and solutions were prepared with glass distilled water.

Bromo cresol green	0·04% aqueous solution
Hydrochloric acid	2 N
Ammonium oxalate	Filtered saturated aqueous solution
Ammonium hydroxide	About 2% aqueous solution
EDTA stock solution	10 milli-equivalents per litre prepared by dissolving analar disodium ethylenediamine tetraacetic acid in distilled water
Mg stock solution	50 milli-equivalents per litre prepared by dissolving analar magnesium acetate tetrahydrate in distilled water
Eriochrome-Black T indicator	Dissolve 25 mgm. of Eriochrome Black T in 25 ml. of 2-methoxy ethanol (Methyl cellosolve). This solution is stable at room temperature for three to four weeks
EDTA-Ethanolamine reagent solution	(5 milli-equivalents per litre). A mixture of 3 ml. of ethanolamine and 50 ml. of stock EDTA solution is diluted to 100 ml. with distilled water. The solution should be prepared fresh every time
Standard magnesium solution	5 milli-equivalents per litre

Procedure.—Pipette out 5 ml. of EDTA ethanolamine reagent in 15 ml. centrifuge tube, add 2 drops of Eriochrome-Black T indicator and titrate it against standard Magnesium working solution.

Dilute 5 ml. of sea-water to 50 ml. with distilled water. To 1 ml. aliquot of diluted sea-water, add 10 ml. of EDTA-ethanolamine reagent and titrate against standard magnesium solution using Eriochrome-Black T indicator. This will give total concentration of magnesium, calcium and strontium.

Transfer one ml. of sea-water sample to centrifuge tube and make up to 4 ml. with distilled water. Add two drops of bromo-cresol green indicator, two drops of 2 N HCl and one ml. of saturated ammonium oxalate solution. Heat in a water-bath to about 90° C. and add 2% ammonia drop by drop till the colour has just changed from green to blue. After 10 minutes in water-bath, allow to stand at least four hours at room temperature. Centrifuge and decant the supernatant.

Wash the precipitate once with 2% ammonia and then redissolve by adding three drops of 2N hydrochloric acid, 4 ml. of water and heat in a water-bath. As soon as the precipitate has dissolved, reprecipitate by the addition as before of indicator, ammonium oxalate and ammonia. After heating for 10 minutes in water-bath allow to stand for four hours at room temperature. Centrifuge and wash the precipitate three times with 2% ammonia. After final washing dissolve the precipitate in three drops of 2N HCl. Add 5 ml. of EDTA ethanolamine and titrate against standard magnesium solution using Eriochrome-Black T indicator.

Magnesium in sea-water is calculated from the difference between the first and second determinations. Chlorinity determinations were made by titrating sea-water samples with $AgNO_3$ as described by Viswanathan *et al.*[1] The values obtained for Magnesium/chlorinity ratios by titrimetry and Atomic Absorption Spectrophotometry are given in Table I.

TABLE I

Magnesium/chlorinity ratios determined by the present and the atomic absorption spectrophotometric methods

Magnesium/chlorinity ratio by EDTA titration	*Magnesium/chlorinity ratio by Atomic Absorption Spectrophotometry
0·0706	0·0732
0·0722	0·0739
0·0709	0·0717
0·0709	0·0720
0·0731	0·0744
0·0709	0·0713
0·0725	0·0713

* Values taken from Viswanathan *et al.*[1]

From Table I it is seen that the Magnesium/chlorinity ratio is found higher in the Arabian Sea than those reported by Culkin[6] for other regions which range from 0·0663 to 0·0681.

Our thanks are due to Dr. A. K. Ganguly for his interest in the work.

Health Physics Division, S. M. SHAH.
Bhabha Atomic Research S. S. GOGATE.
Centre,
Bombay-74 (AS), October 4, 1968.

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SOME LEAF IMPRESSIONS FROM THE KASAULI SERIES OF THE SIMLA HILLS

ABSTRACT

Six species of monocotyledon and dicotyledon leaf impressions are described from the suggestive of close proximity of the source rocks and the basin of deposition.

THE material which forms the basis of present study was collected by the author from the micaceous sandstone of the Kasauli Series exposed near Banog Grahat (30° 50′ 07″, 76° 59′ 30″) on the left bank of the Koshalia river. Plant fossils were also found to occur at the following places:

(*i*) About 1·5 km. downhill of the Kurar bridge on the left bank of the Koshalia river; (*ii*) Near Kasauli Water Works on the Kalka-Kasauli bridle path; (*iii*) Near Kasauli bazar; (*iv*) Kasauli sandstones exposed at the Dagshai Ridge; and (*v*) At a number of places between Kumarhatti and Barog on the Kalka-Simla Highway.

Medlicott[3] collected some leaf impressions from the Kasauli beds of the type area (Kasauli) which were studied by Dr. Kane. Fiestmantel[2] sketched and described *Sabal major* Heer from the Kasauli and Murree beds. In a posthumous paper Sahni[4] described angiosperm leaf impressions from the Kasaulis of the type area (Kasauli).

Owing to the poorly preserved nature of the plant fossils it was not possible to make specific identification.

A. MONOCOTYLEDONS

Poacites sp. (Fig. 1)

The leaf fragment has an entire margin with parallel veins. It is 17 cm. long and 0·8 cm. broad. A depression in the middle (throughout the length) perhaps indicates the presence of midrib.

Specimen Number—PKc-64.

Remarks.—The present leaf impression has been described under the genus *Poacites* which includes impressions of grass-like leaves of unknown affinity.

Palmophyllum sp. (Fig. 2)

The specimen shown in Fig. 2 represents an impression of a palm leaf more probably that of a part of fan palm. The preserved length is 9 cm., the width 3 cm. towards the apex, while at the base it is 0·5 cm. From the base arise six prominent veins which diverge towards the apex.

Specimen Number—PKc-16.

B. DICOTYLEDONS

Dicotylophyllum sp. 1 (Fig. 3)

Only the lower half of the leaf is preserved which is 3 cm. in breadth possessing an entire margin and a prominent midrib. The petiole is 0·7 cm. in length.

Specimen Number—PKc-2 *a*.

Remarks.—The leaf impression is comparable with the one described by Sahni (*op. cit.*).

Dicotylophyllum sp. 2 (Fig. 4)

The leaf is 11 cm. long, 4 cm. broad and possesses an entire margin. It has an obtuse apex and a cuneate base. It is an oblong lanceolate with a prominent midrib. At one place the lateral veins are also prominent appearing sub-opposite and arise at an angle of about 70 degrees. The distance between the two laterals of the order of 0·5 cm.

Specimen Number—PKc-1.

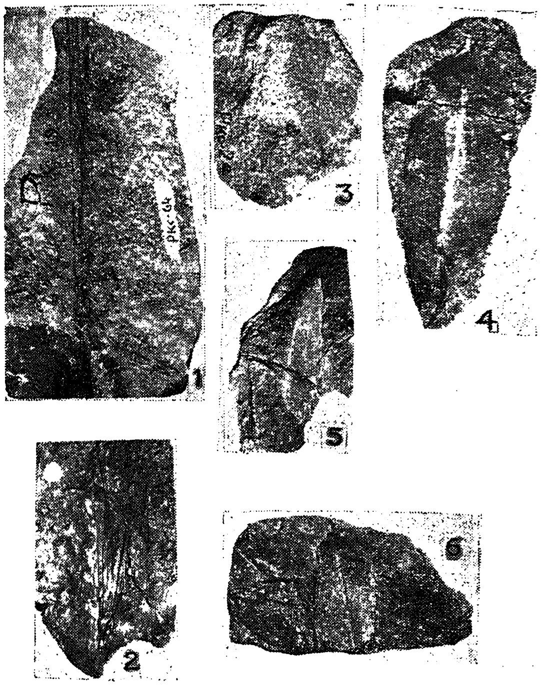
Remarks.—The leaf impression resembles *Dicotylophyllum* sp. 2 described by Sahni (*op. cit.*).

Dicotylophyllum sp. 3 (Fig. 5)

The leaf has an entire margin and is 10 cm. long and 2 cm. broad. It is lanceolate with an acute apex. The midrib is seen; other details are not clear.

Specimen Number—PKc-3.

Dicotylophyllum sp. 4 (Fig. 6)



FIGS. 1–6. Fig. 1. Grass-like leaf impression *Poacites* sp., $\times \frac{2}{3}$. Fig. 2. Impression of a part of fan palm *Palmophyllum* sp., $\times \frac{1}{2}$. Fig. 3. Impression of lower part of a dicot leaf showing prominent midrib and petiole *Dicotylophyllum* sp. 1, $\times \frac{2}{3}$. Fig. 4. Impression of a complete dicot leaf showing midrib and lateral veins *Dicotylophyllum* sp. 2, $\times \frac{2}{3}$. Fig 5. Impression of a complete dicot leaf showing prominent midrib *Dicotylophyllum* sp. 3, $\times \frac{1}{2}$. Fig. 6. Impression of a complete dicot leaf showing prominent midrib *Dicotylophyllum* sp. 4, $\times \frac{2}{3}$.

The fossil leaf impression is 5 cm. long, 2·5 cm. broad and has an entire margin. It is elliptic in shape with an acute apex. Midrib well preserved; other details are not clear.

Specimen Number—PKc-4.

Due to poor preservation, the fossil leaf impressions do not afford much towards the reconstruction of the geological history. The organic remains, however, are indicative of the close proximity of source rocks and the basin of deposition. The later fact supports the contention held by the author[1] about the provenance of the Kasauli sediments.

The age of the Kasauli Series is precisely well defined[1a] and ranges from Upper Oligocene to Lower Miocene. The age of the fossil flora described in this paper is, therefore, Lower Miocene as the leaf impressions occur towards the top of the Kasauli Series which attain a thickness of 2,136 mt. in this area. This is in harmony with the view held by Fiestmantel[2] and Sahni.[4]

The author is grateful to Professor P. R. J. Naidu and Professor I. C. Pande for the facilities provided, and to Mrs. S. Sahni, Drs. K. R. Surange, R. N. Lakhanpal, U. Parkash and R. Dayal of the Birbal Sahni Institute of Palæobotany, Lucknow, for extending co-operation.

Centre of Advanced Study in Geology,
Panjab University, Chandigarh,
July 29, 1968.
R. S. CHAUDHRI.

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PHENOTYPIC STABILITY OF HYBRIDS AND VARIETIES IN GRAIN SORGHUM

AN ideal variety is one that combines high yield and stability of performance. Stability assumes added importance in breeding dry land crops, the yields of which are subject to climatic fluctuations. Since Finlay and Wilkinson[3] proposed a linear regression analysis of general adaptation, attempts have been made to analyse the stability of performance in crops like barley and wheat.[2,5] Using a model developed by Eberhart and Russel,[1] the stability of performance of two commercial sorghum hybrids CSH-1 and CSH-2, the tall improved local varieties and a recently developed improved variety *Swarna*, a hybrid derivative, is examined. Stability is described by three parameters, mean yield, regression of mean yield on an environmental index and deviations from regression.

Grain yields obtained under rainfed conditions over a period of five years at 7-12 locations per year, representing diverse environments under which *kharif* (July-November) sorghums are cultivated in India over an approximate area of 12 million hectares, are evaluated. The rainfall was normal during the years 1963, 1964 and 1967, while severe drought was experienced at several locations during 1965 and 1966. The grain yields over years and locations fluctuated from less than 200 kg./hectare to over 5000 kg./hectare, thus, providing a representative range of environments. The parameters estimated may, therefore, be expected to provide satisfactory measures of stability.

The stability parameters estimated from this study are presented in Table I. It will be seen that the mean yields of the hybrids are consistently superior under normal and stress environmental conditions over the locals, CSH-1 being superior to CSH-2. The improved variety S. 413 has shown a tendency to outyield CSH-1 under favourable environmental conditions only, a detailed performance of which was presented earlier by Rao *et al.*[7] The local checks are consistently low yielding. The size of the regression coefficients for the locals, in general, are lower than the hybrids as well as the improved variety ($b < 1 \cdot 0$). Relative to the hybrids, the regression coefficient is greater for *Swarna* ($b > 1 \cdot 0$). Although the average regression coefficients of the hybrids are of similar magnitude and near $1 \cdot 0$, the differences in b's are maximum in years where the mean yields are higher as in 1965 and 1967. The deviations from regression are maximum in CSH-2 during 1963 and 1965 indicating that under certain environmental conditions the departure from linearity is substantial for CSH-2. While the high mean yields in the hybrids are associated with larger deviations from linearity, the behaviour of the locals is erratic.

It is often stated that hybrids, in general, are economically feasible in areas of adequate rainfall or under irrigation.[8] The consistency of performance of sorghum hybrids under normal and stress environmental conditions has belied the general belief that the hybrids are for favourable environmental conditions only. CSH-1 appears to be the best genotype that has consistently high performance over several environments. The hybrid CSH-2 and the improved variety *Swarna* tend to outyield CSH-1 as the environment becomes more and more favourable. The locals are consistently low yielding. The degree of heterozygosity, the diversity in the origin of alleles and the nature of gene action in the material under study could furnish the possible causes for the differential behaviour. The local checks are pure lines selected under low fertility conditions and most of them are late maturing.

TABLE I

Stability parameters for hybrids and varieties

Year	CSH-1			CSH-2			*Swarna* (S. 413)			Local check			Grand mean Q /ha.
	Mean Q /ha.	*b*	Deviation	Mean Q./ha.	*b*	Deviation	Mean Q./ha.	*b*	Deviation	Mean Q /ha.	*b*	Deviation	
1963 (7)*	23·37	1·15	14·64	18·30	1·11	38·03	—	—	—	13·02	0·73	72·64	18·23
1964 (8)	26·76	0·95	15·63	23·75	1·04	13·91	—	—	—	18·66	1·01	16·97	23·06
1965 (11)	30·40	0·96	52·55	23·28	1·35	104·16	—	—	—	19·17	0·69	25·17	24·26
1966 (12)	21·66	1·17	19·05	15·21	1·08	9·47	—	—	—	12·93	0·75	57·35	16·60
1967 (12)	32·72	0·75	46·45	25·48	0·98	39·55	30·74	1·25	39·27	20·46	1·01	36·18	27·35
Average ..	26·98	0·996	—	21·20	1·112	—	30·74	1·25	—	16·85	0·838	—	21·90

* Number of locations. – Data not available.

The improved variety *Swarna* has in its parentage an early *kafir* and a late maturing African yellow endosperm type. The hybrids besides being early and completely heterozygous, have a common female parent, male sterile Combine *Kafir* 60, and the male parents are a derived *feterita* and a derived *hegari* respectively. The effective components of yield heterosis in CSH-1 are additive and additive × additive epistasis while in CSH-2, dominance and dominance × dominance components are significant and are in the same direction.[6] Whatever may be the precise cause, hybridity as observed in *Arabidopsis thaliana* by Griffing and Langridge[4] together with the earliness and quicker rate of growth appear to confer greater phenotypic stability as observed in CSH-1. Development of suitable hybrids could, therefore, provide the genetic tool to stabilise the unpredictable and chronically low yield levels of rainfed tracts.

The authors are thankful to Dr. M. S. Swaminathan and Dr. H. K. Jain for their interest and encouragement and Dr. B. R. Murty for comments on manuscript.

Cummings Lab., N. GANGA PRASADA RAO.
Division of Genetics, G. HARINARAYANA.
I.A.R.I., New Delhi-12,
October 9, 1968.

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REVIEWS AND NOTICES OF BOOKS

Classical Network Theory. By V. Belevitch. (Holden-Day, Inc., 500, Sansome Street, San Francisco 94111), 1968. Pp. x + 440. Price $ 21.00.

This book serves as a fundamental theoretical treatise on analysis and synthesis of lumped linear time-invariant passive networks in the complex frequency domain, treating only the fundamental theoretical problems where definitive and complete solutions have been obtained. Non-reciprocal and complex passive elements are included almost from the beginning, the outlook afforded by the state variable approach is considered whenever it appears useful, and the treatment extends up to the most advanced results in *n*-port synthesis.

A working knowledge of matrix algebra and of the theory of analytic functions up to the level normally attained by graduate electrical engineers is assumed.

The contents of this book are: Elements and Connections; Network Analysis; Analysis of *n*-Port; Basic Structures and Transformations; Synthesis of Passive One-Ports; Reflection and Transmission; Positive Matrices and Bounded Matrices; Degree and Canonic Forms; Lossless 2-Ports; Synthesis of Passive *n*-ports; Factorization of Scattering Matrices; and Unitary Bordering of Scattering Matrices. C. V. R.

Projective Plane Geometry. By John Blattner. (Holden-Day, Inc., 500, San Some Street, San Francisco 94111), 1968. Pp. xi + 297. Price $ 11.75.

This book provides a coverage of plane projective geometry, and is intended for a one or two semester course at the junior-senior level. The axiomatic approach uses projective geometry as a natural vehicle for the introduction of many important concepts of modern mathematics, including the concepts of function, inverse function, equivalence relation, group, division ring, field, vector space, linear transformation and isomorphism. Thus, these ideas appear not as pure abstractions, but as natural developments in the course of working out the geometry of projecture planes. In order to achieve relevance to the modern curriculum, the concept of function is used throughout to unify and simplify. All functions used are given names, and composite functions and inverse functions are employed consistently to derive results in a nearly algebraic manner. Other special features include: a strong attempt to motivate the introduction of each axiom on the basis of need and intuitive acceptability; a careful consideration of the finite planes with 7, 13, and 21 points so that the student can develop a feel for the material by working in these highly concrete geometries; a full explanation of the concept of the conjugate of one transformation by another; and many exercises at the end of each lesson size section. C. V. R.

Introduction to Chemistry. By A. L. Williams, H. D. Embree and H. J. DeBey. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1), 1968. Pp. 712. Price 65 *sh.*

This will be a useful text-book to students who have to learn chemistry as a subsidiary subject, or to students of liberal arts whose curriculum includes chemistry as part of the General Science course. The teratment is clear and logical. The book starts with the fundamentals of general chemistry and proceeds to deal in several coherent and distinctive chapters the essentials of inorganic and organic chemistry. The biochemistry part deals with not only carbohydrates, proteins, and lipids, but meaningful chapters are devoted to nutrition, heredity, biochemistry of plants, diseases, and chemotherapy. A. S. G.

A Course in Biology. By J. J. W. Baker and G. E. Allen. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1), 1968. Pp. 403. Price 52 *sh.*

The full-length text *The Study of Biology* by the authors published in the spring of 1967 was reviewed in these columns, *see Curr. Sci.*, 1967, *36*, p. 500. The present publication is a shorter version of the parent book, and will be suitable for a half-year course on general biology. It deals with the most fundamental principles of biology, and emphasises the deductive and experimental aspects of biological ideas. It is an excellent introduction to the subject and will interest the lay reader also.

A. S. G.

Physics for Chemists and Biologists. By D. O. Hughes and J. L. Latham. (Butterworth and Co., Publishers Ltd., 88, Kingsway, London W.C. 2), 1968. Pp. 367. Price 52 *sh.* 6 *d.*

The object of this book is to describe the essential features of physics as an ancillary subject to students of chemistry and biology, emphasising those aspects of the subject which are of immediate importance to them. Chapters are devoted to electromagnetism, current electricity, electronics and electronic devices, electromagnetic theory of light, physical and geometrical optics, heat, and temperature. Derivations of essential results are obtained from first principles and applications are described in detail. The book will be useful also to non-physicists in industry and research.

A. S. G.

Plant Pathologist's Pocketbook. (Compiled by the Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey, England), Pp. 267. Price 30 *sh.*

This publication is the first of its kind for plant pathology. The compilation provides essential information and clues on subjects which any plant pathologist is likely to look for. Several specialists working in particular branches of this field have contributed to this compilation.

The first 166 pages are devoted to description, classification and identification of plant diseases under separate heads such as Fungus Diseases, Bacterial Diseases, Virus Diseases, Non-Parasitic Diseases, etc. There are sections under Plant-Parasitic Nematodes, Insect Pests, Weeds, and Fungicides. About 40 pages are devoted to some common plant diseases in tabular statement under column heads name, pathogen, symptoms, distribution, dissemination, and control. The last 100 pages are devoted to methods and techniques including mycological culture media, formulæ, and above all, guide on preparation of manuscripts for publication.

This pocketbook is an indispensable companion to every professional plant pathologist.

A. S. G.

Key to *Pythium* Pringsheim. By Grace M. Waterhouse, Pp. 15. 7 *sh.* 6 *d.*

The Genus *Pythium* Pringsheim. By Grace M. Waterhouse. Pp. 71 *plus* 50 Plates. Price 50 *sh.*

These two publications form the Mycological Papers No. 109 and No. 110 respectively of the Commonwealth Mycological Institute, Kew, Surrey, England. Since the key given by Middleton in 1943, 31 new specific and sub-specific taxa have been described for the genus. In this revised list there are 89.

The second publication contains the original descriptions and figures of all the taxa. As workers in this field are well aware, the literature on *Pythium* Pringsheim is very scattered and in some cases it is difficult to locate. Thus they will welcome the Key and the collected account.

A. S. G.

Books Received

Music of the Spheres: The Material Universe from Atom to Quasar, Simply Explained (in two volumes). By Guy Murchie. Vol. I, The Macrocosm: Planets, Stars, Galaxies, Cosmology, Pp. xii + 225. Price $ 2.00; Vol. II, Microcosm: Matter, Atoms, Waves, Radiation, Relativity, Pp. 230-644. Price $ 2.00. (Dover Publications, 180. Varick Street, New York-14, N.Y.).

Advanced Calculus. By L. H. Loomis and S. Sternberg. (Addison-Wesley Pub. Co., Inc., London W. 1), 1968. Pp. 580. Price 89 *sh.*

Comparative Biochemistry of the Flavonoids. Tindall. (Oxford University Press, Mount Road, Madras-2), 1968. Pp. xi + 300. Price Rs. 27·00.

Comparative Biochmistry of the Flavonoids. By J. B. Harborne (Academic Press, Inc., London, London W. 1), 1967. Pp. viii + 383. Price 90 *sh.* or $ 16.00.

943-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
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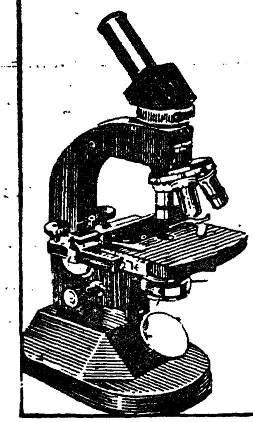

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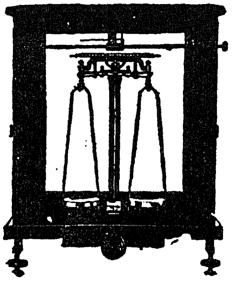

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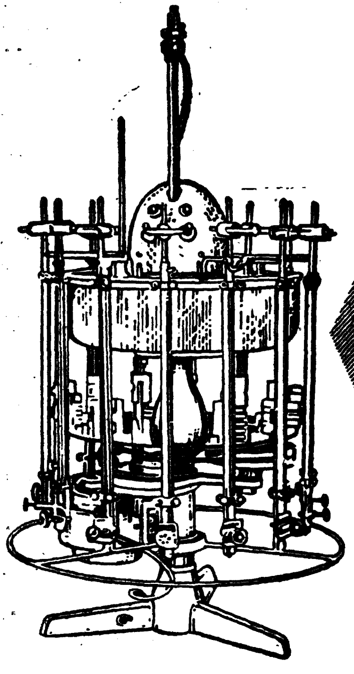

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ISOLATION AND STRUCTURE OF PUTROLIC ACID—A NEW TRITERPENIC SECO-ACID FROM THE STEM-BARK OF *PUTRANJIVA ROXBURGHII* *

G. R. CHOPRA, A. C. JAIN AND T. R. SESHADRI
Department of Chemistry, University of Delhi, Delhi-7

RECENTLY, four new triterpenes, *viz.*, putrone, putrol, putranjivic acid and methyl putranjivate besides β-amyrin, its palmitate and stigmasterol were isolated by us from the leaves of *Putranjiva roxburghii* Wall (*N.O. Euphorbiaceæ*).[1] We report here the isolation and constitution of a new triterpenic seco-acid, putrolic acid from the stem-bark.

Air-dried stem-bark was extracted successively with boiling benzene and alcohol. The alcoholic extract after concentration gave more benzene soluble material. Both were mixed and found to contain mostly triterpenic components. After saponification, they could be separated into a neutral fraction soluble in ether and insoluble colourless gelatinous precipitate. The former when examined by column chromatography over neutral alumina gave a low melting hydrocarbon (0·8%), friedelin (0·006% ; identity confirmed by comparison with authentic sample kindly supplied by Professor P.R. Jefferies), a mixture of terpenic ketones (0·02%) reducible by LAH and stigmasterol (0·015%). The insoluble precipitate was purified better by chromatography after acidification and treatment with diazomethane. It yielded a crystalline methyl ester which on hydrolysis gave putrolic acid (0·5%). In order to make sure if it was present free or as ester, the benzene extracts were subjected to silica-gel column chromatography without prior saponification and putrolic acid was obtained in almost the same yield. It crystallised from $CHCl_3$-MeOH mixture as colourless crystals, m.p. 220–22° ; $[\alpha]_D + 21{\cdot}3°$ (C, 0·475)† ; R_f 0·6 in solvent B, 0·5 in F, 0·3 in G ; $\nu_{max.}$ (nujol) 3500 (OH) and 1718 cm.$^{-1}$ (C=O). The elemental analysis of this and its derivatives showed the mol. formula to be $C_{30}H_{52}O_3$. Either with diazomethane or with methanol containing a trace of acid catalyst, it readily forms methyl ester which is the most satisfactory derivative for constitutional studies. It crystallises from $CHCl_3$-MeOH mixture as colourless long needles, m.p. 175–76° ; $[\alpha]_D - 8{\cdot}3°$ (C, 1·204) ; R_f 0·4 in solvents A and D, and 0·8 in E ; no colour with t.n.m. ; ν_{max} (KBr) 1730 cm.$^{-1}$ (ester C=O) ; $\delta(CDCl_3)$: 3·90 p.p.m. (s, 3H of CO_2CH_3). Elemental analysis and mass spectrum determined its mol. formula as $C_{31}H_{54}O_3$ (M^+ 474). The n.m.r. spectrum of methyl putrolate showed that it is a saturated molecule having 7–8 methyl groups (δ 0·84–1·28 p.p.m.) and a secondary alcohol (δ 4·2 p.p.m., multiplet of one proton of CHOH). The presence of an alcoholic group was confirmed by preparing (*i*) methyl O-acetyl putrolate, m.p. 140–41° ; $[\alpha]_D + 19{\cdot}0°$ (C, 1·04); R_f 0·8 in solvents A and D ; M^+ 516 ; mol. formula $C_{33}H_{56}O_4$; ν_{max} (KBr) 1760 cm.$^{-1}$; $\delta(CDCl_3)$: 2·18 (*s*, 3H of $OCOCH_3$), 3·79 (S, 3H of CO_2CH_3), 5·05 p.p.m. (m, 1H of CHOAc), and (*ii*) *O*-tosyl derivative, m.p. 141–42° ; $[\alpha]_D -$ 27)6° (C, 1·09); R_f 0·70 in solvent A and 0·75 in D ; mol. formula $C_{38}H_{60}SO_5$. The secondary nature of the alcoholic group was shown by Jones' oxidation of methyl putrolate to form methyl oxoputrolate, m.p. 152–54° ; $[\alpha]_D + 24°$ (C, 1·0); R_f 0·9 in solvent A and 0·8 in D ; M^+ 472 ; mol. formula $C_{31}H_{52}O_3$; $\nu_{max.}$ (nujol) 1757 cm.$^{-1}$ (C=O) ; $\delta(CCl_4)$; 3·82 (*s*, 3H of CO_2CH_3), 2·67 p.p.m. (*m*, 2H of CH_2 next to keto), no CHO signal. The molecular formula, the absence of unsaturation (lack of t.n.m. test) and the presence of OH and CO_2H groups in putrolic acid show that it is a triterpenic seco-acid having four rings (I).

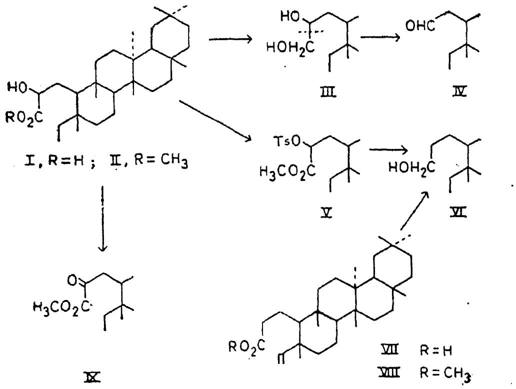
That putrolic acid is an α-hydroxyacid is shown by the following facts. (*i*) The n.m.r. spectrum of methyl putrolate (II) shows no signals for α-methylene group in the region δ 2·3–2·5 p.p.m. (*ii*) The i.r. spectrum of methyl oxoputrolate showed only one carbonyl frequency which behaviour is reminiscent of α-keto esters.[2] (*iii*) LAH reduction of methyl putrolate gives a 1, 2-diol (III) (m.p. 212–14° ; R_f 0·1 in solvent A and 0·3 in C ; mol. formula

---

* This work was presented by one of us (A.C.J.) at the Indo-Soviet Symposium held at Tashkent during Sept. 16–20, 1968.

† $[\alpha]_D$ values are in chloroform solution at 25° and concentration (*c*) in g/100 ml. All R_f values recorded in this paper are on t.l.c. on silica-gel using one of the following solvents. (A) Benzene, (B) Ethyl acetate : light petroleum (1 : 4), (C) Chloroform, (D) Light petroleum : chloroform (1 : 1), (E) Light petroleum : methanol (98 : 2), (F) Ethyl acetate : benzene (1 : 9), (G) Chloroform : methanol (85 : 15). Satisfactory analytical figures were obtained for the compounds where molecular formulæ are shown.

$C_{30}H_{54}O_2$) which undergoes cleavage with periodic acid to give formaldehyde (positive chromotropic acid test), and another aldehyde (IV), m.p. 187°; $[\alpha]_D + 11 \cdot 6°$ (C, 1·2); R_f 0·9 in solvent A, 0·8 in D; mol. formula $C_{29}H_{50}O$; $\nu_{max.}$ (KBr) 1724 cm.$^{-1}$ (C=O); silver mirror with Tollens reagent; δ ($CDCl_3$): 9·7 (*s*, 1H of C*H*O), 2·34 p.p.m. (*m*, 2H of CH_2 next to keto).



I, R=H ; II, R=CH$_3$

III

IV

V

VI

VII R=H

VIII R=CH$_3$

IX

A comparison of the mass spectra of methyl putrolate (II), its *O*-acetyl and oxo (IX) derivatives with methyl putranjivate showed the same base ion 205 besides many common ion peaks below mass ion 301. Hence putrolic acid could be related to putranjivic acid. This was established by LAH reduction of methyl O-tosyl putrolate (V) (*see* ref. 3 for similar hydrogenolysis of tosylate) when an alcohol (VI) m.p., 178°; $[\alpha]_D + 4 \cdot 2°$ (C, 0·952); R_f 0·40 in solvents A and D, 0·65 in E; mol. formula $C_{30}H_{54}O$, was obtained which was identical in mixed m.p., i.r. spectrum and t.l.c. with the alcohol obtained from methyl putranjivate (VIII) by catalytic hydrogenation followed by LAH reduction. Hence putrolic acid has structure (I) and the various transformations and relation to putranjivic acid (VIII) could be represented by structural formula.

Very recently, two publications[4,5] have appeared on investigation of the bark of the same tree. Sengupta *et al.*[4] isolated besides friedelin putranjivadione and friedelanol, a new triterpenic ketone which was named roxburgholone and given the structure of 3 α-hydroxyfriedelan-7-one. They did not report any acid component. On the other hand, Garg and Mitra[5] did isolate the acid which was named putranjic acid, and considered to be hydroxy triterpenic acid but not assigned any structure. The m.p. and spectral data of putranjic acid and its two derivatives are very close to those of putrolic acid and its derivatives but the molecular formulæ differ. Garg and Mitra further reported the presence of an unidentified sterol, friedelin, putranjivadione and putranjivanonol. The last compound seems to be the same as roxburgholone of Sengupta *et al.*[4]

---

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MAGNETIC SYMMETRY AND ELASTIC COEFFICIENTS

T. S. G. KRISHNAMURTY AND P. GOPALAKRISHNAMURTY
Andhra University, Waltair

ELASTICITY expresses the relation between the applied stress and the resulting strain both of which are known to be represented by the second rank symmetric tensors. Bhagavantam and Suryanarayana[1] have enumerated the second and the third order elastic coefficients in respect of the 32 crystal classes employing the character method. Jahn[2] obtained identical results using the method of reduction of a representation. Krishnamurty[3] and Krishnamurty and Gopalakrishnamurty[4] have computed the number of non-vanishing independent fourth order elastic coefficients for the 32 classes of crystals. Since piezomagnetism is the appearance of a magnetic moment on the application of a stress (Bhagavantam[5]), one is led to investigate the connection between the two phenomena, namely piezomagnetism and elasticity, in crystals. This will be explained in what follows. Accordingly in this note the number of the second, the third and the fourth order elastic coefficients for each one of the 58 double-coloured magnetic point groups is derived on the basis of Jahn's[2] method.

If V denotes the representation of a polar vector and [V^2] represents the symmetrical product (Tisza[6]) of V with itself, the values of the second and the third symmetrical powers of $[V^2]$ representing respectively the second and the third order elasticity have already been given by Jahn. In the case of the fourth order elasticity, the reduced form of the representation has been recently obtained by the authors.[4] These results are reproduced in Table I.

TABLE I

Reduced forms of the representation of polar vectors

No.	Representation	Reduced form of the representation
1	$[[V^2]^2]$	$2D_0+2D_2+D_4$
2	$[[V^2]^3]$	$3D_0+3D_2+D_3+2D_4+D_6$
3	$[[V^2]^4]$	$4D_0+5D_2+D_3+4D_4+D_5+2D_6+D_8$

It has been shown by the authors[7] that the real non-total symmetric one-dimensional irreducible representations (alternating representations) of a crystallographic point group not only induce the magnetic variants associated with the point group but also give the number of constants required to describe any physical property for the induced magnetic variants. Following Jahn's method and from the non-equivalent alternating representations of the 32 point groups, the second, the third and the fourth order elastic coefficients of the 58 double-coloured magnetic point groups have been enumerated here. These will simply be given by the numerical coefficients of the alternating representations of the 32 point groups in the reduced form of the appropriate representation characterising the elastic property under consideration. The results so obtained are given below against the distinct inducing alternating representations. Tisza's notation for the description of the alternating representations of the 32 point groups is adopted (Herzberg[8]) below:

m : A'' (8, 24, 56); 2 : B (8, 24, 56); $2/m$: B_g (8, 24, 56); $2mm$: B_1 and A_2 (4, 12, 28); 222 : B_3(4, 12, 28); mmm : B_{1g}(4, 12, 28); 4 : B(6, 16, 34); $\bar{4}$: B(6, 16, 34); $4/m$: B_g (6, 16, 34); $4mm$: A_2(1, 4, 11) and B_1(3, 8, 17); $\bar{4}2m$: B_1 and B_2 (3, 8, 17), A_2(1, 4, 11); 422 : A_2(1, 4, 11) and B_1(3, 8, 17); $4/mmm$: A_{2g} (1, 4, 11) and B_{1g} (3, 8, 17); $3m$: A_2(1, 6, 14); 32 : A_2(1, 6, 14); $\bar{3}m$: A_{2g} (1, 6, 14); $3/m$: A''(2, 8, 18); 6 : B(2, 8, 18); $6/m$: B_g(2, 8, 18); $\bar{6}m2$: A_2' (0, 2, 5), A_2'' and A_1'' (1, 4, 9); $6mm$: A_2(0, 2, 5) and B_1(1, 4, 9); 622 : A_2(0, 2, 5) and B_1(1, 4, 9); $6/mmm$: A_{2g} (0, 2, 5) and B_{1g}(1, 4, 9); $\bar{4}3m$: A_2(0, 2, 3); 432 : A_2(0, 2, 3) and $m3m$: A_{2g}(0, 2, 3).

Here the figures in brackets appearing against an alternating representation of a conventional point group represent respectively the numbers of the second, the third and the fourth order elastic coefficients required by the dichromatic magnetic point group induced by that alternating representation of the point group. The 21 alternating representations of the 32 point groups in each of which the centre of inversion is represented by the character -1 are not included in the above list since they do not give rise to the elastic coefficients of any order.

It is interesting to note that the piezomagnetic coefficients[9,10] also vanish in respect of the 21 double-coloured magnetic point groups induced by the 21 alternating representations referred to above. The vanishing of the piezomagnetic and the elastic coefficients for these 21 dichromatic point groups is due to the fact that the former are represented by axial tensors of odd rank, while the latter are characterised by polar tensors of even rank, both of which are centro-symmetric. It may be observed that the existence of the piezomagnetic phenomenon in crystals implies that of elasticity, whereas the converse may not be true.[10] That the converse is not true is evident from the elastic and the piezomagnetic constants of crystals corresponding to the point groups $\bar{4}3m$, 432 and $m3m$.[1,10]

The authors' thanks are due to Prof. T. Venkatarayudu for his interest in the problem.

---

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ON THE STRATIGRAPHIC POSITION OF THE SIMLA SLATE AND CHAIL OF THE SIMLA AREA

A. RANGA RAO AND C. L. BHAN
O.N.G. Commission, Dehra Dun

IN the areas to the north of Simla, Pilgrim and West (1928) mapped the slates occurring above the Naldera limestone and below the Chail thrust as Simla slates. The limestone-slate alternations, underlying the Naldera limestone with an 'apparently normal contact' and above the Shali thrust, were considered to be of the lowest stage of Chail series. These authors assigned a Purana age to the Chail, and Lower Paleozoic to Pre-Cambrian to the Simla slate.

In 1939 in his paper on the 'Structure of the Shali Window' West observes: "Very careful examination of the zone of rocks that forms the base of the Simla slates and the top of Lower Chails, right across sheet 53 E/4, has failed, however to reveal any break in the sequence.........., it is therefore tentatively concluded that the two are one and the same series, the Simla slates at and north of Simla representing the Middle and Upper Chails" (*Rec. Geol. Surv. India*, Vol. 74, Pt. 1, p. 161).

Recent examination of this area by the authors, while confirming the above conclusion reached by West, brought another important geological fact into light, namely, the whole sequence rests in normal superposition over a considerable thickness of Trap. This is well exposed on the Bhal Ki Dhar to the northwest of Tattapani (31° 15′ : 77° 05′ 30″). Here the basal part of 'Chail' is separated from the Trap by a boulder bed with thickness varying from 2 ft. (as on the Tattapani-Karsog road one mile from Tattapani) to nearly 50 ft. as near Bui (31° 18′ 20″ : 77° 0′ 40″), suggesting an unconformity at the top of the Trap. The boulders are well rounded and chiefly consist of white quartzite with trap detritus as matrix. West (1938, *Rec. G.S.I.*, Vol. 73, p. 96) considered that this Trap is a representative of the Panjal Trap of Carboniferous age.

At the top, the Simla slate is unconformably overlain by Nummulitics in several small erosion outliers between Halog and Subathu. Preliminary faunal studies have indicated an Upper Paleocene age to the Nummulitics of this region. This would mean, that, what has been mapped as Simla slate and Chail below the Chail thrust to the north of Simla, constitute a single group of rocks and are intermediate in age between the Trap (? Panjal Trap-Carboniferous) and the Nummulitics (Upper Paleocene). It is of interest to note here that the Kakarhatti limestones show collenia-type growths and on this basis have been correlated with Shali Limestone by Misra and Valdiya (1961, *Journ. Geol. Soc. Ind.*, Vol. 2, pp. 78-90). If this data is reliable, it is possible that the Trap below the Simla slate may not be time equivalent of the Panjal Trap but older to it.

The sequence between the Trap and the Nummulitics can be divided into four mappable rock-stratigraphic units on the basis of vertical variation and horizontal persistency in lithology. Table I gives the stratigraphic and tectonic sequence established by the authors along with the one given by Pilgrim and West (1928) and West (1939).

TABLE I

	Authors:			*Pilgrim and West* (1928); *West* (1939)
		Chail of Simla Klippe		Chail Series
		Chail Thrust		Chail Thrust
		Nummulitics	Paleocene	Nummulitics
		Unconformity		Unconformity
SIMLA GROUP	Simla slate	Shales with minor quartzite		Simla slates
				? ?
	Kakarhatti formation	Limestones and shales		Lower Chail
	Bui formation	Shales and gritty quartzites Boulder bed		
		Unconformity		
	Samana formation	Trap with intertrappean quartzites		
		Shali Thrust		Shali Thrust
				TRAP
		Shali Group		Shali Group

On the basis of the above observations, it is suggested that the usage of the term 'Chail' should be restricted only to the more metamorphosed rocks; talcose quartzites, quartz-schists and phyllites of the Chor area where Pilgrim and West first recognised them as a separate unit. With the existing status of geological mapping in this part of Himalaya, it is not possible to say whether or not what has been mapped as Simla slate in the Chakrata area and further east are time equivalents of the Simla slate of Simla.*

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RARE CHIMAEROID AND ELASMOBRANCH FISHES FROM THE CONTINENTAL SLOPE OFF THE WEST COAST OF INDIA *

E. G. SILAS
Central Marine Fisheries Research Institute, Mandapam Camp
AND
DANIEL SELVARAJ AND A. REGUNATHAN
Central Marine Fisheries Research Substation, Gopala Prabhu Cross Road, Ernakulam, Cochin-11

ABSTRACT

During exploratory trawling from the upper continental slope in depths between 180 and 450 metres off the West Coast of India, specimens of the Chimæroid fish *Neoharriotta pinnata* (Schnackenbeck) and the rare elasmobranchs *Echinorhinus brucus* (Bonnaterre) and *Atractophorus armatus* Gilchrist have been obtained. All three are new distributional records for Indian Seas and they are described and illustrated.

DURING exploratory trawling from the upper continental slope in depths between 180 and 450 metres carried out by R.V. *VARUNA* and other vessels, several interesting fishes and invertebrates hitherto unknown from Indian Seas have been brought to light. Three such interesting finds are: a chimæroid fish *Neoharriotta pinnata* (Schnackenbeck) (Subclass Holocephali, Family Rhinochimæridæ) and two deep-water sharks, namely *Echinorhinus brucus* (Bonnaterre) (Family Dalatiidæ), and *Atractophorus armatus* Gilchrist (Family Squalidæ). Specimens of *N. pinnata* have hitherto been caught only from the equatorial coast of West Africa and South-West Africa (Smith, 1961). An egg case suspected to be of this species was reported from the south-west coast of India (Balakrishnan, 1963). We have been able to obtain two such egg cases and the present definite record of adults of *N. pinnata* from this area helps to confirm the identification of the egg cases.

E. brucus is known to inhabit deeper waters in the warm seas (Bigelow and Schroeder, 1948; Smith, 1961), while *A. armatus* is known to occur in the deeper waters off Natal Coast and Mozambique (Smith, 1961). Brief diagnosis of each species accompanied by outline drawings are given here to facilitate identification.

Neoharriotta pinnata (SCHNACKENBECK, 1931), FIG. 1*a*

Two adult females from 12° 17′ N, 74° 13′ E, depth 360 m, on 24–5–1968; and five juveniles (2 males and 3 females) from 12° 12′ N, 74° 10′ E, depth 396 m, on 24–5–1968, both during R.V. *VARUNA* Cruise 128; two empty egg cases from 10° 53′ N, 75° 08′ E, depth 180–206 m, on 27–4–1968 during R.V. *VARUNA* Cruise 127.

Diagnosis of Adults.—Total length 1125 and 1240 mm. respectively. Head 32·7–33·5, trunk height 33·3–33·7, snout length in front of eye 21·3–23·2, and in front of mouth 18·7–21·1, oblique diameter of eye 3·1–3·6, inter-orbital distance 4·6–4·9, width of gill-opening 5·7–5·8, first predorsal distance 32·6–33·9, second predorsal distance 50·7–51·2, prepectoral distance 33·2–34·6, prepelvic distance 50·1–50·2, preanal distance 71·2–73·0, height of first dorsal fin 11·1–11·5, length of pectoral fin 14·2–14·9, length of pelvic fin 9·9–10·0, length of anal fin 5·7–6·1, length of upper caudal lobe along caudal base 22·1–22·7, and lower caudal base 22·6–22·9% of total length. Weight 3·4 and 4·75 kg. respectively.

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Echinorhinus brucus (BONNATERRE, 1788), FIG. 1 *b*

One male, 1620 mm. in total length and 29 kg. in weight from 12° 06′ N, 74° 23′ E, depth 405 m, on 27–7–1968 during R.V. *VARUNA* Cruise 129.

Diagnosis.—Snout 7·4, mouth to tip of snout 8·0, horizontal diameter of eye 2·7, inter-orbital distance 8·9, width of first gill-opening 4·1, fifth gill-opening 6·5, first predorsal distance 63·5, second predorsal distance 70·9, distance from snout to base of caudal (upper) 77·5, prepectoral distance 27·8, prepelvic distance 60·2, snout to first gill-opening 21·0, and to last gill-opening 27·8, vertical height of first dorsal 4·3, and of second dorsal 5·1, length of pelvic fin 15·3, greatest depth of body 17·0, interspace between first and second dorsal 4·9 and of second dorsal and caudal 3·7% in total length. Body covered with tubercles of radiating bony structure, each with a central spine. Tubercles whitish.

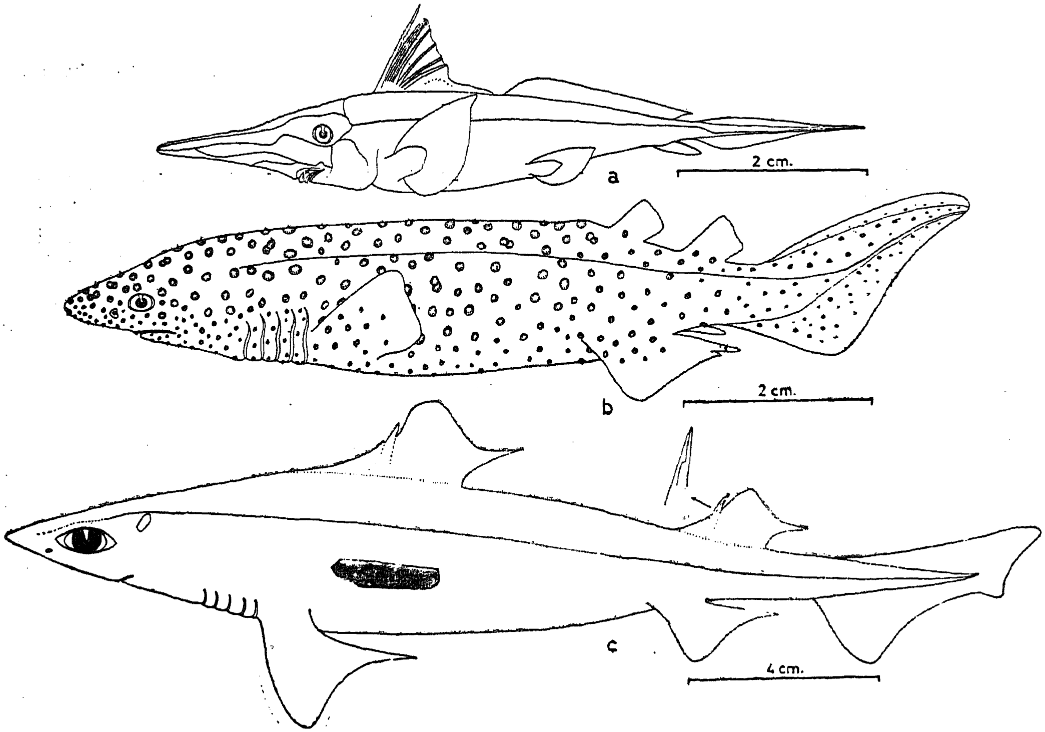
2 cm.
a
2 cm.
b
c
4 cm.

FIG. 1. (*a*) *Neoharriotta pinnata* (Schnackenbeck) female 124 cm.; (*b*) *Echinorhinus brucus* (Bonnaterre) male 162 cm.; and (*c*) *Attractophorus armatus* Gilchrist, female 92·2 cm. in total length.

Atractophorus armatus GILCHRIST, 1922, FIG. 1 *c*

Seven females, 841 to 943 mm. in total length from 09° 00′ N, 75° 42′ E, depth 329 m, on 12–11–1968 during fishing from M. V. KLAUS SUNNANA.

Diagnosis.—Snout tip to inner nares 4·0–4·6, width of mouth 7·6–8·6, horizontal diameter of eye 5·9–6·2, inter-orbital distance 7·6–9·1, snout tip to spiracle 12·6–16·7, first predorsal 33·5–37·0, second predorsal 68·5–70·5, snout to base of caudal (upper) 71·5–83·7, prepectoral distance 23·9–25·4, prepelvic distance 59·1–61·8, greatest depth of body 13·9–16·0, length of first dorsal spine 5·3–6·6, and of second dorsal spine 3·9–5·2, vertical height of first dorsal 6·4–7·7, of second dorsal 5·3–6·1, interspace between first and second dorsals 24·0–26·6, interspace between second dorsal and caudal base 6·5–7·3, length of pectoral fin from origin to posterior tip 15·8–18·3, and of pelvic fin 10·3–11·4% in total length. Weight 3·25 to 5·50 kg.

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LETTERS TO THE EDITOR

SOLUBILITY OF BARIUM IN SEA-WATER IN PRESENCE OF DISSOLVED ORGANIC MATTER

THE concentration of barium in sea-water calculates to 30 µg./l. (Krauskopf, 1956); Chow and Goldberg (1960) obtained a value of 52 µg./l. Turekian and Johnson (1966) report values evenly distributed within the wide range of 5 to 65 µg./l. for barium concentration in sea-waters collected from different regions of the world. Recently Burton (1968) in a laboratory experiment using Ba^{133} labelled barium sulphate obtained a saturation value of 48 µg. Ba/l. in sea-water collected from English channel, filtered through 0·5 µ membrane filter and containing initially 10 µg. Ba/l.

Barium sulphate is the least soluble compound formed with a major anion in sea-water and its solubility in the medium was attempted to be understood principally on the basis of interaction with dissolved inorganic constituents present in sea-water. Chow and Goldberg (1960) found that barium concentrations in several oceanic water columns from Pacific increased with depth. They suggested that this increase may be related to the biochemical cycles in the sea. The barium in solution is taken to be present either as a divalent barium ion or as undissociated dissolved barium sulphate, perhaps not exceeding 5% of the total barium in solution. Possible association of barium with such ions as phosphate, silicate, bicarbonate, carbonate and hydroxide is not significant since their concentrations are very low when compared with the sulphate concentration in the ambient. Koshy *et al.* (1968) demonstrated the interactions of metallic ions like Zn, Fe and Zr-Nb with dissolved organics in sea-water.

Preliminary experiments in this laboratory indicated a dominant influence of dissolved organics present in sea-water in solubilizing barium and/or barium sulphate. To confirm the above, the following experiment was conducted.

An algal culture of *Chlorella* species was grown in sea-water (collected from near-shore regions of Bombay, India) medium for six months and allowed to decay for two years under conditions of ambient temperature, constant pH (8·2) and constant concentration of inorganic constituents. The culture supernate was filtered through 0·22 µ millipore membrane filter. The culture filtrate on analysis, was found to contain the usual amino-acids (concentration not determined) and carbohydrates (1·77 µg./ml.) that are known to occur in sea-water (*cf.* Duursma, 1965). Pillai *et al.* (unpublished work) have also detected similar amino-acids in the hydrolysates of the humic acid prepared from marine sediments. Experiments were conducted using barium chloride solution and precipitated barium sulphate labelled with Ba^{133}.

Experiments were conducted taking 10 ml. of sea-water (found to contain 0·3 mg./l. of carbohydrates), and 10 ml. of culture solution—both filtered through 0·22 µ millipore membrane filter. To each of these was added 100 λ of $Ba^{133}Cl_2$ solution corresponding to 6·77 µg. of barium, for *in situ* precipitation of barium sulphate.

In the experiment with precipitated barium sulphate, Ba^{133} labelled barium sulphate (~ 2 mg. each) was taken in three stoppered tubes and 10 ml. each of double distilled water, 0·22 µ filtered sea-water and culture solutions were added in respective tubes. These were kept for a week with intermittent shaking. Solutions were then filtered through 0·22 µ millipore membrane filter and aliquots (5 ml.) were taken for counting. For calibration of gamma counting set-up, 100 λ $Ba^{133}Cl_2$ in 5 ml. of water and 4·1 mg. $Ba^{133}SO_4$ dissolved in 5 ml. ammoniacal EDTA were taken. The results obtained are presented in Tables I and II.

TABLE I

Solubility of in situ *precipitated* $BaSO_4$ *in sea-water and culture solution*

Specific activity : 117 cpm/µg. Ba

Sample	Ba^{133} in solution cpm	Ba solubility µg. Ba/l.
Added Ba ..	792 (6·77 µg.)	..
Sea-water (5 ml.)	101·4	173·3
	95·5	163·2
*Culture (5 ml.)	351	599·6
	376·4	643·4

* Two values are for two batches of the culture solution.

TABLE II

Solubility of precipitated $BaSO_4$ in distilled water, sea-water and culture solutions

Specific activity: 9·683 cpm/μg. $BaSO_4$

Sample	Ba activity in solution cpm	Ba solubility μg./l.
Distilled water (5 ml.)	116·2	1411 (2400 μg. $BaSO_4$/l)
Sea-water (5 ml.)	10·86	132·3 (224·4 μg. $BaSO_4$/l.)
*Culture (5 ml.)	43·74	523·8 (903·7 μg. $BaSO_4$/l.)
	38·80	471·1 (801·3 μg. $BaSO_4$/l.)

* Two values are for two batches of the culture solution.

The results show a much higher amount of Ba^{133} in solution in the presence of organic matter. To check the validity of the method, $BaSO_4$ solubility in double distilled water was found out in a simultaneous experiment (of Table II) and the solubility (2·4 mg./l.) was in agreement with the reported values of 2·30 ± 0·22 mg./l. (Burton *et al.*, 1968). The sulphate concentration in sea-water and culture was found out to be 2035 μg./ml. and 2934 μg./ml. respectively. Although culture had a high sulphate content, total barium dissolved was much higher than in sea-water. High values of barium obtained in sea-water by precipitated $BaSO_4$ and *in situ* precipitated $BaSO_4$ indicate the solubilization of barium by organic matter in sea-water containing 0·3 mg./l. of carbohydrates. Organic concentrate from this sea-water on analysis showed the presence of several amino-acids (Pillai *et al.*, 1968).

It was further intended to find out the nature of barium in solution in the presence of organic matter. So 4 ml. of the culture with solubilized $barium^{133}$ was passed through a Dowex 50 column (5 cm. × 1 cm.) conditioned to the Na form with 3·5% NaCl and the column was washed with 6 ml. of 3·5% NaCl solution. The column effluent and washings did not show any gamma activity and the entire activity was accounted for by counting of the column bed. Thus in combination with the dissolved organic compounds in sea-water, barium is in the cationic or cationic complex form. In another experiment the precipitated $Ba^{133}SO_4$ dissolved in ammoniacal EDTA (1·7 mg./ml. at pH 9), filtered through 0·22 μ millipore membrane filter and then passed through a similar column in NH_4 form behaved as above, the activity being quantitatively retained by the column.

Health Physics Division,
Bhabha Atomic Research
Centre,
Trombay, Bombay-74 (India),
October 29, 1968.

M. V. M. DESAI.
ELIZABETH KOSHY.
A. K. GANGULY.

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FORCE CONSTANTS AND MEAN-SQUARE AMPLITUDES OF VIBRATION OF HEXACHLOROURANATE ION (UCl_6^{2-})

RECENTLY Woodward and Ware[1] have given the vibrational frequencies of hexachlorouranate ion. In the present communication we report the force constants employing modified Urey Bradley Force Field (MUBFF) and generalised quadratic potential field (GQPF). F-G matrix elements and symmetry elements have been taken from literature.[2,3] From the computed results as shown in Table I it appears that the results are better reproduced with the general quadratic potential field than MUBFF.

TABLE I

Force constants of hexachlorouranate ion (UCl_6^{2-})

MUBFF	mdyne/Å	GQPF	mdyne/Å	Observed frequencies (cm^{-1})	Calculated from MUBFF (cm^{-1})	Calculated from GQPF (cm^{-1})
K	0·961 43	f_r	1·263,57	$\nu_1 = 299$	299	299
F	0·210,27	f_{rr}	0·115,65	$\nu_2 = 237$	237	237
H	−0·039,22	$f_{r\alpha}-f_{r\alpha}''$	0·021,34	$\nu_3 = 262$	270	261·88
h	0·004,80	$f_{\alpha}-f_{\alpha\alpha}'''$	0·084,71	$\nu_4 = 114$	94	113·99
k	0·064,30	$f_{\alpha\alpha}-f_{\alpha\alpha}''$	0·008,28	$\nu_5 = 121$	121	121
		$f_{\alpha\alpha}'-f_{\alpha\alpha}'''$	0·008,94	$\nu_6 = 80$	80	80
		f_{rr}'	0·140,57			

TABLE II

Generalized mean-square and mean-amplitude quantities in hexachlorouranate ion (UCl_6^{2-})

Distance	Mean-square amplitude quantities, $10^{-4} \times A^2$				Mean amplitude quantities, A		
	Symbol	T = 0° K	T = 298° K	T = 500° K	T = 0° K	T = 298° K	T = 500° K
U——Cl	$\langle \Delta Z^2 \rangle$	17·181	31·237	48·681	0·0415	0·0559	0·0693
	$\langle \Delta X^2 \rangle$	56·861	227·790	376·783	..	..	..
	$\langle \Delta Y^2 \rangle$	56·861	227·790	376·783	..	..	..
Cl——Cl (linear)	$\langle \Delta Z^2 \rangle$	37·334	68·872	107·556	0·0611	0·0830	0·1037
	$\langle \Delta X^2 \rangle$	39·275	138·261	227·865	..	..	..
	$\langle \Delta Y^2 \rangle$	39·275	138·261	227·865	..	..	..
Cl——Cl (non-linear)	$\langle \Delta Z^2 \rangle$	76·130	250·465	409·741	0·0873	0·1583	0·2024
	$\langle \Delta X^2 \rangle$	57·877	185·693	303·098	..	..	..
	$\langle \Delta Y^2 \rangle$	79·044	380·591	632·336	..	..	..

The generalised mean square amplitude quantities and the mean amplitudes of vibration were evaluated using the expressions of Bye and Cyvin[4] at three temperatures, T = 0° K, T = 298° K and T = 500° K. The results are presented in Table II. From the results it appears that the mean amplitudes of vibrations for bonded as well as the non-bonded distances increases with temperature.

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Department of Physics, A. N. PANDEY.
University of Gorakhpur, H. S. SINGH.
Gorakhpur, India, NITISH K. SANYAL.
October 28, 1968.

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STRUCTURE OF AN ARABIAN SEA SUMMER MONSOON SYSTEM

THE International Indian Ocean Expedition (IIOE) data for June-July 1963 have been discussed by Miller and Keshavamurthy[1] in their Monograph on the subject. The author has studied the same data with reference to the synoptic charts and three papers are under publication in the India Meteorological Department. Some of the important conclusions arrived at in those papers are stated below to enable meteorologists to appreciate the correct position:

(*a*) The period 26 June to 10 July 1963 consisted of two distinct active phases of the Arabian Sea Monsoon as judged from rainfall on the west coast of the Peninsula.

(*b*) The soundings at 12° N, 52° E. and 12° N, 54° E. on 26 June show that the low-level inversion at the latter location was an airmass one. The same type of airmass stratification was observed in the central and east Arabian Sea north of about 10° N.

(*c*) A cyclonic vortex was present in the northeast Arabian Sea off the Bombay coast only from 2 to 4 July. There were 'Triple point' and 'Perpendicular action' conditions from 5 to 10 July.

(*d*) Moist easterly air from the Bay of Bengal side was not present in the vortex from 2 to 4 July.

(*e*) Aircraft data at 500 mb. level on 2 July showed presence of cold dry and warm moist airmasses over the northeast Arabian Sea. Temperature data at different levels become intelligible if lapse rates in the different airmasses are taken into account. There was no mid-tropospheric cyclone.

(*f*) It is seen from aircraft data that on 2 July conditions at 550 and 500 mb. levels were different. On 4 July also conditions at 560 and 500 mb. levels were different. Data for 560 or 550 mb. level could not, therefore, be used to get idea about conditions at 500 mb. level.

(*g*) Sounding data near 20° N., 70° E. on 7 July become intelligible if the 'Triple point' conditions present near the area at different levels and causing changes in airmass stratification are taken into account.

(*h*) Soundings on 8 and 9 July when there was no vortex and the monsoon was actually weakening, show that within about 500 km. of the west coast of the Peninsula, the thickness of the moist layer and the height of base of inversion increase eastwards towards the Western Ghats.

(*i*) The Western Ghats affected rainfall on the entire west coast.

The author's study shows that the IIOE data fit in well with the views hitherto held by the Indian meteorologists by modifying them slightly to explain absence of the low-level inversion and increased depth of the moist current over the west coast of the Peninsula when the monsoon is active or strong.

173, Swami Vivekananda Road, B. N. DESAI.
Vile Parle (West),
Bombay-56, *December* 13, 1968.

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PREPARATION AND ABSORPTION CHARACTERISTICS OF NEODYMIUM-PONGAMOL COMPLEX

RARE earth complexes have received considerable attention because of their possible application in the development of lasers.[1] With a view to investigate the fluorescence properties of rare earth complexes with oxygen donor ligands, pongamol has been chosen. In previous communications[2,3] the preparation and spectral properties of some rare earth pongamol complexes were reported. The present communication details the characterisation of neodymium-pongamol complex.

The neodymium complex was prepared and purified by following the method described previously for the other rare earth ions.[2,3] The elemental analysis of the chelate indicates that the metal to ligand ratio is 1 : 3 (Found: C = 62·3; H = 4·1; Nd $(C_{18}H_{13}O_4)_3 \cdot H_2O$ requires C = 62·25; H = 4·06%).

The absorption spectra of the ligand and the chelate were recorded in the ultraviolet region using a Hilger-Watts spectrophotometer and in the Infrared region using a Perkin-Elmer Model-137 Infra cord. The solid compound was examined as Nujol Mull.

In the ultraviolet region the ligand in chloroform exhibits two absorption band maxima—one at 350 mμ, $\epsilon = 24, 110$; and the other at 250 mμ, $\epsilon = 23, 040$. In the chelate the two band maxima could be located—one at 350 mμ, $\epsilon = 61, 480$ and the other at 250 mμ, $\epsilon = 62, 630$ in chloroform. Evidently, there is a large intensification in the ϵ values in the complex.

In the infrared region the diketone now investigated showed two bands at 1600 cm.$^{-1}$ and 1550 cm.$^{-1}$ These may be the enol chelate and the perturbed carbonyl absorptions respectively. In the infrared spectra of metal diketonates studied by Morgan[4] and Lecomte[5] a strong absorption band was noticed between 1562 cm.$^{-1}$ and 1550 cm.$^{-1}$ in a series of eleven acetylacetonates. This was attributed to the carbonyl group weakened by the resonance between C–O–M and C=O……M. A second band near 1515 cm.$^{-1}$ is located which was attributed to the C=C stretching. In the neodymium complex now investigated two strong bands are located at 1530 cm.$^{-1}$ and 1500 cm.$^{-1}$ These may be attributed to C=O and C=C absorptions respectively.

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Dept. of Chemistry, V. RAMACHANDRA RAO.
Marathwada University,
Aurangabad,
and
Dept. of Chemistry, P. RADHAKRISHNA MURTY.
Osmania University,
Hyderabad-7, *August* 28, 1968.

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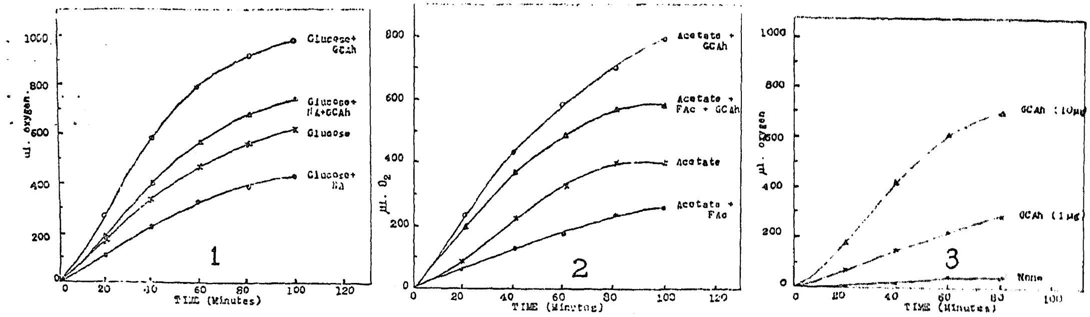
ROLE OF GLUCOSE CYCLOACETOACETATE HYDROLYSATE ON THE OXIDATION OF GLUCOSE AND ACETATE IN *ESCHERICHIA COLI 113-3*

A REPORT based on some preliminary observations from our laboratory indicates a stimulatory effect of glucose cycloacetoacetate hydrolysate (GCAh) on oxidation reactions in *Escherichia coli 113–3*.[1] Attempts were made in the present investigation to elucidate the role of GCAh in glucose and acetate oxidation in this micro-organism. Sodium arsenite (NA) and sodium fluoroacetate (FAc) were chosen as inhibitors of glucose and acetate oxidations respectively, and the effect of GCAh on these oxidations were studied.

E. coli 113–3 was obtained from N.C.L., Poona. The stock cultures on agar slants were subcultured weekly and stored at 5°, Cells were grown on glucose and harvested in the medium suggested by Davis and Mingioli[2] supplemented with 100 µg. of DL-methionine per ml. Cell suspensions were prepared according to the method of Mitra.[3] GCAh was prepared according to the procedures of Nath and Nath.[4] Oxidation rates were measured at 37° using conventional Warburg techniques under air. Additions of the reaction components were carried out as indicated in Figs. 1-3. After the oxidation studies were completed, pyruvic acid and citric acid were estimated by the methods of Walker *et al.*[5] and Natelson *et al.*[6] respectively.



FIGS. 1–3. Fig. 1. Glucose oxidation. *Flask contents:* 40 µM glucose, 10 µM sodium arsenite (NA), 10 µg GCAh, 100 mM potassium phosphate buffer (pH 7·0); N content, 1·1 mg. *Pyruvic acid formed:* glucose ± GCAh, 0; glucose + NA, 9 µM; glucose + NA + GCAh, 9 µM. Fig. 2. Acetate oxidation. *Flask contents:* 40 µM acetate, 8 µM gluoroacetate (FAc), 10 µg GCAh, 100 mM potassium phosphate buffer (pH 7·0); N content 1·1 mg *Citric acid formed:* acetate ± GCAh, 0; acetate + FAc, 0·6 µM; acetate + FAc + GCAh, 0·7 µM. Fig. 3. GCAh oxidation. *Flask contents:* 1 µg. or 10 µg. or no GCAh, 100 mM potassium phosphate buffer (pH 7·0); N content 0·9 mg.

Figure 1 represents the rates of glucose oxidation in *E. coli 113–3*. Sodium arsenite inhibits the oxidation rate of glucose resulting in accumulation of pyruvic acid as earlier observed.[7] GCAh could reverse this inhibition on oxidation but could not affect pyruvic acid accumulation. Similarly, acetate oxidation could be lowered to a greater extent by FAc resulting in the formation of citric acid (Fig. 2). While GCAh could reverse this inhibition to a marked level, citric acid accumulation remained unchanged. From these results it is evident that GCAh is not directly helping any of these oxidations. GCAh might be having some stimulatory effect on some alternate pathways of these substrates utilisation or might undergo oxidation in the micro-organism. The possibility of a by-pass in these substrates utilisation is eliminated because GCAh alone can be oxidised by the organism (Fig. 3). A striking similarity in the oxidation rates of glucose + NA + GCAh (Fig. 1), acetate + FAc + GCAh (Fig. 2) and GCAh (10 µg.) (Fig. 3) further supports the possibility of the existence of an enzyme system in the micro-organism by which GCAh can be oxidised as a substrate. Increased rates of oxidation when GCAh alone was added (Figs. 1 and 2) seem to be due to the combined oxidations of the respective substrate as well as GCAh. These studies reveal that GCAh has no direct effect on either glycolytic or T.C.A. pathways and also that the oxidation of GCAh is not mediated through these pathways.

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Department of Biochemistry, Nagpur University, Nagpur, *December* 31, 1968.
B. SIVAKUMAR.
N. NATH.
M. C. NATH.

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EFFECT OF VASECTOMY ON BIOCHEMICAL COMPOSITION OF THE RAT TESTICULAR FLUID

RECENT studies on long-term effect of vasectomy in rats have shown no impairment of gametogenic and endocrine functions of the testis.[1] It seemed to be of interest to examine whether the operation alters the biochemical composition of the testicular fluid in this species. It has been reported that this fluid is a rich source of substrates and co-factors some of which may be involved in spermatogenesis and steroid biosynthesis.[2]

Colony-bred adult albino rats of the Institute (180–200 gm.) were vasectomized according to the procedure of Kar *et al.*[1] coeval animals served as unoperated controls. All of them were killed 180 days after the operation. Methods of collection of the testicular fluid and the analytical techniques were the same as employed previously.[2]

It will be evident from the results presented in Table I that the only changes evoked by vasectomy were a reduction in lactic dehydrogenase and acid phosphatase activity, and a lowering of ascorbic acid concentration. The other parameters (pH, total protein, glucose-6-phosphate dehydrogenase, glycogen and lactic acid) did not record any alteration.

TABLE I

*Vasectomy and biochemical composition of rat testicular fluid**

Parameter	Control	Vasectomized
pH ..	7·2	7·2
Total protein (Gm/.100 ml.)	6·60† (6·45–6·918)	6·60 (6·450–6·675)
Lactic dehydrogenase (Units/mg. protein/min.)	0·055 (0·051–0·058)	0·046 (0·044–0·047)
Glucose-6-phosphate dehydrogenase (Units/ml.)	362·5 (325–400)	338·0 (325–350)
Acid phosphatase (Mg. P/hr./100 ml.)	65·5 (59·2–71·8)	40·3 (39·8–40·8)
Glycogen (Mg./100 ml.)	15·0 (14–16)	16·5 (16·0–17·0)
Lactic acid (Mg./100 ml.)	273·7 (247·8–293·9)	300·6 (279·5–311·2)
Ascorbic acid (Mg./100 ml.)	11–15 (10·8–11·5)	7·15 (6·8–7·5)

* Data based on three replicate analyses of pooled sample from 50 tests. † Mean with range in parenthesis.

The reduction in lactic dehydrogenase activity in the testicular fluid of operated rats in spite of the virtual constancy of lactic acid level is intriguing. The loss of acid phosphatase activity is noteworthy and suggests a decrease in total energy production in the testis. Whether this has any bearing on the loss of fertilizing capacity of spermatozoa of some men after otherwise successful re-canalization of the vas,[1] cannot be assessed from the present preliminary data.

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Lucknow (Communication No. 1308),
October 8, 1968.

J. K. PANDE.
P. R. DASGUPTA.
AMIYA B. KAR.

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CO-DISTILLATION CLEAN-UP FOR DDT RESIDUES ESTIMATION

ABSTRACT

DDT and DDE co-distil with water. Small quantities of carrier solvents such as acetone, methanol, isopropanol and monoethyl ether of ethylene glycol aid and render such co-distillation quantitative. This finding has been utilized to advantage in developing a simple clean-up technique for the estimation of microamounts of DDT in materials of high fat content. The approach dispenses with the use of large quantities of costly solvents and adsorbents.

INVESTIGATIONS related to the methodologies of pesticides residues estimations, at this Institute, resulted in observations that DDT and DDE[1] co-distil with water and that such co-distillation could be further aided through the use of small quantities of carrier solvents such as acetone, isopropanol, methanol and monoethyl ether of ethylene glycol (cellosolve or oxitol) to yield quantitative recoveries of DDT and DDE from aqueous suspensions containing 10 micrograms to 20 milligrams of DDT or DDE. Co-distillation of DDT with water has also been reported in other contexts.[2–4]

The above-mentioned property of DDT and DDE offered promise for the segregation of these entities from extractives of plants, plant products, soils and animal products. The studies resulted in utilization of the observations in the development of a simple and inexpensive clean-up technique for the estimation of DDT residues in vegetables such as potatoes and lady's-fingers—*Abelmoschus esculentus* and fatty materials such as milk, eggs and oils.

The technique developed entailed shaking the substrate with a suitable solvent acetone or a solvent mixture consisting of two parts of petroleum ether 40–60° C. and one part of thiophene free benzene; removal of the solvent from the extractives or from an aliquot of the extractives; transferring the residue quantitatively with 10 ml. acetone and 20 ml. isopropanol to a two-litre capacity distillation flask; adding to the contents of the flask 1000 ml. water; distilling; and allowing the droplets of about 800 ml. distillate to pass through a train of absorption columns containing the solvent mixture. An apparatus designed for the purpose enabled complete isolation of the toxicant from the distillate with less than 50 ml. of the solvent mixture. The solvent phases from the columns are combined, the solvent evaporated off at 40° C. under a current of dry air protecting escape of DDT or DDE at this stage by using two drops of propylene glycol as fixative, and the residue so obtained is then processed through the Schechter and Haller colorimetric procedure[6] as per further details recommended by the DDT Panel.[5]

The technique has been used successfully in determining microamounts of DDT in white and yolk of the eggs. Recoveries from samples fortified with 50 μg. to 1 mg. DDT ranged from 90 to 112%.

In milk and oils alkali hydrolysis of the extractives and subsequent estimation of DDT, through DDE, is essential. Extractives from the substrates, after the removal of solvents, are hydrolyzed with alcoholic potassium hydroxide and the hydrolysates re-extracted with *n*-hexane, residue from which is then taken up in carrier solvents, and processed through the co-distillation technique. Quantitative recoveries were obtained from samples fortified with 50 μg. to 1 mg. DDT.

The additional step of hydrolysis, in case of milk and oil samples, not only facilitates the application of co-distillation clean-up for the segregation of DDT and DDE but also brings about the much desired rupture of fat globule membrane, essential for true recoveries and reliable residue data for these essential commodities.

This simple, expedient and economic new approach for the estimation of traces of DDT in high fat content commodities curtails drastically the use of costly solvents and practically dispenses with the chromatographic adsorbents the use of which entails frequent cumbersome calibration.

Division of Agricultural
Chemicals,
Indian Agricultural
Research Institute,
New Delhi-12, *October* 22, 1968.

R. S. DEWAN.
K. C. GULATI.

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MINERALOGY OF A CHROME-MICA FROM A QUARTZITE VARUNA VILLAGE, MYSORE

CHROME-MICAS have been reported and described from many localities throughout the world and the status of the knowledge has been summarised by Whitmore.[1] Among the Indian occurrences, not many are found in literature.[2-5] A small belt of hornblende-schists, occurs 3 miles to the east of Chamundi Hills, near the village Varuna, Mysore District, which is considered to be the extension of the Nagamangala schist belt, occurring as discontinuous stringers and patches. The schist belt runs over 7 miles northwards from Varuna village with a width of 2 furlongs. The belt forms a small ridge whose trend is also N-S.

The schist is composed of large-sized prismatic crystals of hornblende, ranging from 1–1½" in length, and garnet. The belt is bordered on either side by hornblende-gneiss. Amidst this schist belt are found small narrow intercalated bands of kyanite-quartzite and chrome-mica bearing quartzite, which is very localised in its occurrence. Its strike is N 20° W to S 20° E. and dips at an angle of 70° towards east.

The quartzite exhibits a mosaic texture composed of quartz, chrome-mica with accessory rutile and sphene. The rutile or sphene sometimes alter to a brown patch possibly limonite(?). There are relics of kyanite in these chrome-mica bearing quartzites.

The optical properties are presented in Table I together with other chrome-micas for purposes of comparison:

TABLE I

Optical characters	1	2	3	4
Refractive indices:				
$\alpha =$	1·560	1·568	1·566	1·563
$\beta =$	n.d	1·595	1·597	1·596
$\gamma =$	1·599	1·598	1·602	1·598
(−) 2V =	30°	32°	38°±1°	35°
Pleochroism:				
X =	Light green			
Y =	Green			
Z =	Bluish-green			
Birefringence ($\gamma - \alpha$)	0·038	0·040	0·036	0·035
Specific gravity =	2·830	..	2·850	2·819
XZ plane perpendicular to	(010)	(010)	..	..

1. Chrome-mica from Varuna, Mysore Dt.
2. Mariposite from Belavadi, Mysore State, Naidu and Khan[5].
3. Fuchsite from Silurian quartz-conglomerate, Newhampshire, Clifford.[4]
4. Fuchsite from Mashishimala, S. Africa, Partridge.[3]

The difference in the value of the optic axial angle observed in the Varuna sample can be attributed to the tenor of Cr_2O_3 in the mineral.

Since the material was scanty and could not be obtained 100% pure, a partial analysis of the mineral was undertaken by Rapid method of analysis.[6] The partial analysis comprises SiO_2, Al_2O_3, Cr_2O_3, Fe_2O_3, K_2O and H_2O. The chemical analysis is presented in Table II together with another analysis for comparison:

TABLE II

Constituents		1	2
SiO_2	..	47·71	44·40
Al_2O_3	..	30·83	31·70
TiO_2	..	n.d.	2·10
Fe_2O_3	..	2·15	2·30
Cr_2O_3	..	1·03	2·10
FeO	..	n d.	..
MnO	..	,,	0·05
MgO	..	,,	0·70
CaO	..	,,	0·10
Na_2O	..	,,	1·10
K_2O	..	9·87	10·70
H_2O	..	3·93	4·70
Total	..	95·52	99·95

1. Chrome-mica, Varuna, Analyst: S. K. Babu.
2. Fuchsite from Quartz-conglomerate, Newhampshire, Analyst: J. Ito.

The analysis of the chrome-mica from Varuna, though not complete, agrees fairly well with the fuchsite from quartz-conglomerate of Newhampshire described by Clifford.[4] It differs from it in having more silica, and less Cr_2O_3. Hutton[7] suggests the term chromiferous muscovites for the chrome-micas containing less than 1% Cr_2O_3 and fuchsite for those containing more than 1% Cr_2O_3. The analysed mineral on the basis of Cr_2O_3 content falls just on the border between fuchsite and chromiferous muscovites. As such, the author prefers to call it as chrome-mica.

In Varuna area, the chrome-mica occurs associated with lenticular bodies of kyanite-quartzite and hornblende-plagioclase granulites in proximity with Chamundi granite. Similar occurrence of chrome-mica with kyanite, rutile and hornblende in contact with granites has been described by Partridge.[3] In regard to the origin of chrome-mica from Varuna, the associations point to a metamorphic origin, possibly derived from the reaction of pre-existing chrome-minerals with potash, alumina and silica from a siliceous magmatic source. Further, the association of chrome-mica with kyanite, red rutile, sillimanite and brown hornblende points to its formation at a high temperature and pressure condition.

The author records his gratitude to Prof. W. D. West for his encouragement.

Dept. of Applied Geology, S. K. BABU.
University of Saugor,
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THE EFFECT OF pH ON THE OVIPOSITIONAL RESPONSES OF THE YELLOW FEVER MOSQUITO, *AEDES AEGYPTI* L.

MOSQUITOES in nature show specific preference in selecting oviposition sites. The choice of egg laying sites has been found to be influenced by the physical and chemical properties of water in *Culex pipiens quinquefasciatus* Say.[1] The physical and chemical nature of such waters may serve as stimuli for the ovipositing behaviour of the gravid females. It has been shown that in *Aedes ægypti* var. *queenslandis* Theobald ovipositional responses are influenced by at least five different stimuli.[2] The tropicopolitan yellow fever mosquito, *Aedes ægypti* L. is known to breed in nature in various types of waters. Under laboratory conditions, the gravid females of this mosquito were found to prefer 0·25% salt solutions to distilled water.[3] However, no studies have been reported in *A. ægypti* on the effect of hydrogen-ion concentration of water on their ovipositional responses. The object of the present study was to assess such responses in laboratory colonies of *A. ægypti*.

The mosquitoes used in the present study were from strains of *A. ægypti* maintained in the laboratory since 1967. Newly emerged adults, 25 males and 25 females, previously isolated in small vials at pupation, were released into 16 × 16 × 18-inches screened cages fitted with cloth sleeve on one side. The females were given blood meal on alternate days from the 3rd day of emergence. Nine solutions of different graded hydrogen-ion concentration were used as media for oviposition in these experiments. These test solutions were prepared from 0·2 M stock solutions of the following chemicals using standard procedures. Thus pH 2·0 solution was prepared from KCl and HCl; pH 3·6, 4·0 and 5·0 solutions from sodium acetate and acetic acid; pH 6·0, 7·0 and 8·0 solutions from Na_2HPO_4 and KH_2PO_4; and pH 9·2 and 10·0 solutions from sodium carbonate. 200 ml. of each test solution was taken in a 250 ml. beaker which was provided with an inner lining of paper-towel for egg laying. The beakers were placed at random in the cages and the arrangement was changed on every day to avoid bias on the test positions. The eggs laid in each beaker were scored on alternate days. The duration of the experiment was fifteen days with eight replicates.

TABLE I

Effect of various pH solutions on egg laying in A. ægypti

pH of the solution	Percentage of total eggs laid in replicates I to VIII								Av. of per cent. eggs laid with S.E.
	I	II	III	IV	V	VI	VII	VIII	
2·0	7·3	5·7	1·6	0·8	7·9	10·0	7·2	0·2	5·0 ± 1·2
3·6	..	..	..	..	..	..	..	..	..
4·0	..	..	..	..	..	..	..	..	..
5·0	..	..	..	..	..	..	..	..	..
6·0	42·6	48·8	20·5	42·9	31·4	27·2	41·5	41·3	36·9 ± 3·4
7·0	18·9	13·8	2·7	12·2	2·4	11·1	11·8	10·1	10·3 ± 1·9
8·0	2·1	2·8	11·1	2·4	17·2	18·1	4·9	8·2	8·3 ± 2·3
9·2	21·2	18·4	43·9	36·5	28·6	23·7	27·0	29·4	28·3 ± 3·0
10·0	7·9	10·3	20·1	4·8	12·4	9·7	7·5	10·8	10·4 ± 1·6

The oviposition responses to the various media were expressed as percentages of the total eggs laid and the average per cent of eggs laid with standard error in each case was calculated from the replicates (Table I). Ovipositional preference was positive for solutions containing phosphate, carbonate and chloride ions. Maximum egg laying of 36·9% was found to occur in the phosphate solution of pH 6·0 while the other phosphate solutions of pH 7·0 and 8·0 had only 10·3% and 8·3% egg laying respectively. The next highest 28·3% was found in the carbonate solution of pH 9·2. The ovipositional responses in the pH 10·0 and pH 7·0 were almost equal. Similarly *A. dorsalis* (Meigen) has been reported to breed in waters ranging from pH 6·0 to 10·1 while *A. nigromaculis* (Ludlow) was found inhabiting waters with a pH range from 4·7 to 9·2.[4,5]

The strong acidic medium of pH 2·0 with chloride ions had the lowest percentage of egg laying. It is interesting to note that *A. ægypti* avoided the media with pH 3·6, 4·0 and 5·0 all containing acetate ions. Thus the acetate ions were found to be repellent to ovipositional stimuli in this mosquito. The present work also reveals that the chemical nature of the water could act as a definite stimulus for luring or repelling the mosquitoes in oviposition. The broad spectrum of egg laying preference of *A. ægypti* as reported here could account for their wide spread occurrence in diverse habitats.

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Department of Zoology, M. K. K. Pillai.
University of Delhi, B. V. R. Madhukar.
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REDISCOVERY OF *BUGULELLA CLAVATA* HINCKS, 1887 (ECTOPROCTA)

Apart from the original description of *Bugulella clavata* (Hincks)[1] from camera lucida sketches of the type material which has since been lost, no further detailed reference is to be found in the literature regarding this species. Harmer[2] referred to the species, but did not mention anything about the paratype. The type locality of *Bugulella clavata* being the Mergui Archipelago the present discovery of the species from the east coast of India is of interest. Only three fragments of a colony were obtained, from a sponge collected at a depth of 5 m. from the Krusadai Island, Gulf of Mannar. The limited amount of material, available at present for study, makes a detailed description of this rare and interesting species difficult.

This species can be redescribed as follows: Zoarium erect, greyish-white, the zoœcia long and sub-truncate with an arched distal end, tapering proximally. The aperture long and ovate, its length being more than three-fourth that of the front. Frontal membrane translucent. The operculum of membraniporine type is semicircular in outline. Cryptocyst absent. Two avicularia present, one at each disto-lateral angle, directed laterally, each articulating with a rounded tubercle (Fig. 1, *a*, *b*; Fig. 2). Each avicularium has a downcurved rostrum with a bent tip to the mandible, in general shape closely resembling that of *Bugula*.

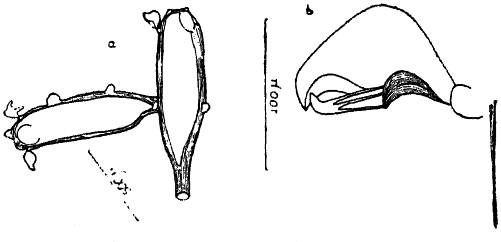

Fig. 1, (*a*) Two Zoœcia. (*b*) Avicularium, lateral view.

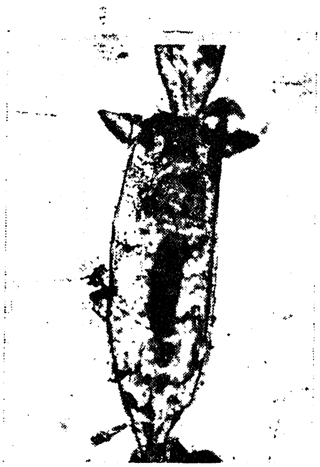

Fig. 2. Photomicrograph of a zoœcium.

Hincks[1] felt that his description of this species was imperfect. The present record has helped in improving the original description by the addition of a few important features of this species, such as the nature and shape of the operculum, absence of cryptocyst, the mode of articulation and shape and disposition of the avicularia.

The organization of this species is simple, apparently approaching *Aetea*, although the boat-shaped zoœcia are more like those of *Beania* or *Bugula* than those of *Actea*. This simplicity may be secondary, derived by reduction from the more complex forms found in the Bicellariellidæ, to which it was referred to by Hincks (1887)[1] and where it may be left for the time being.

Indian Ocean Biol. Centre, N. Ravindranatha Menon.
National Institute of Oceanography,
Cochin-16 (India),
and
The Marine Biol. Laboratory, N. Balakrishnan Nair.
University of Kerala,
Trivandrum-7 (India),
October 9, 1968.

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METASTRONGYLUS SALMI GEDOELST, 1923—THE PIG PARASITE

Two piglets of the Army Service Corps, Bangalore, which died of pneumonic symptoms were brought to the College for post-mortem. There was a heavy infection of lung worms. Eight males and 8 females taken at random from a collection of about 200 worms were cleared and examined. They were identified as *Metastrongylus salmi* basing on the description given by Soulsby (1965) and figures given by Yorke and Maplestone (1926) after Gedoelst. The average length of males was 16·3 mm. with spicule from 1·9 to 2·1 mm. with a single barb. The females had an average length of 32·3 mm. with the tail 95 microns long bent under the body on the ventral surface. Vagina 1·2 mm. Soulsby (1965) has tabulated the differential characters of the lung worms of the pig, *viz*., *Metastrongylus apri*, *M. salmi* and *M. pudendotectus*. *M. pudendotectus* is easily differentiated from the other two by its small spicule 1·2 to 1·4 mm. with a double barb at its tip and the female having a cuticular swelling covering the anus and vagina. A marked difference between *M. apri* and *M. salmi* is in the length of the spicule. In the former it is 4 to 4·2 mm. and in the latter 2 to 2·1 mm.

Enquiries made at the farm of the Army Service Corps revealed that the present stock of about 50 yorkshires were bred from a pair obtained about 15 years ago. Definite information was not available wherefrom this pair was obtained. Pneumonia and respiratory disturbances appear to have become more frequent among the young stock for the past three or four years.

Soulsby (1965) states that *M. salmi* is rarely found in Europe, occurring principally in the Congo, Far East, and the Southern United States. Skrjabin (1952) has noted that "until recently recorded only in Belgian Congo, Northern America and Indo-China. In USSR recorded in Belorussia and Transcaucasus. Apparently universal". This is the first record of the parasite in India.

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Dept. of Parasitology, N. S. Krishna Rao.
Mysore Veterinary M. S. Jagannath.
College,
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DISTRIBUTIONAL RECORDS OF TWO TAXA IN NORTHERN INDIA

During my survey of the vegetation of Delhi State and its neighbourhood, spread over four consecutive years (1964-1968), I found the following two species growing wild:

1. ***Micrococca mercurialis*** **(Linn.) Benth.**

Annual, 20–30 cm. high; sparsely branched. Leaves 2–3·5 cm. long, crenate. Perfect stamens 3, staminodes ("scales") 3 or 4, equalling the stamens in size. Other details conform to the description given earlier.[4] Rare.

Collection Number: K. M. M. Dakshini, 924, 969, 2799, 4710.

Locality: Surajkund—in shady depressions.

Flowers and Fruits: September.

2. ***Butomus umbellatus*** **Linn.**

Perennial, rhizomatous, scapigerous, aquatic herb. Both leaves and scape 40–45 cm. high. Leaves linear, triquetrous, twisted, subacuminate; leaf-base sheathing. Flowers 1 cm. in diameter, in many-flowered umbels. Perianth lobes pink with a prominent green costa. Stamens 9, all fertile; Carpels 6, style persistent. Very rare.

Collection Number: K. M. M. Dakshini, 926, 949, 3710, 4707.

Locality: Najafgarh Lake and Near Hindon River.

Flowers: August-September.

Although both taxa are recorded in *The Flora of British India* (Vol. 5: Pp. 412, 1887; Vol. 6: Pp. 562, 1893, respectively), they have not been reported in the subsequent plant records.[5,3,11,12,15,8,9] *M. mercurialis* and *B. umbellatus* occur in restricted localities and the populations are rather small. This suggests a recent distribution of these taxa in and around Delhi.

M. mercurialis is a rainy season annual and flourishes only in shady depressions which are more moist and humid than the regions from which it is conspicuously absent. This indicates the spread of *M. mercurialis* from distinctly more humid regions.[4] A preliminary examination of the specimens collected by me from Southern India and Agra, and those from

Khetri (Rajasthan),[10] showed a gradation in the size of plant, as well as the number of perfect stamens in relation to the habitat ranging from the moist regions of the South to the progressively semi-arid regions of the North. Whether or not these variations are mere ecological adaptations or due to karyologic evolution needs investigation.

B. umbellatus is sporadic in India; it has been recorded only from Panjab and Kashmir, in marshes at an altitude of 1000–5000 ft.[7] It is also common in Iraq,[13] Canada,[6] and U.K., Europe, Temperate Asia, and North America.[1,2] Being an inland freshwater plant, and in view of its restricted occurrence in India and its absence in the neighbouring countries,[14-16] the occurrence of *B. umbellatus* in the neighbourhood of Delhi State is difficult to explain. Cytological, ecological and phytogeographical studies may provide rewarding clues.

I am grateful to Professor B. M. Johri for encouragement, and to Dr. N. S. Rangaswamy for valuable suggestions.

Department of Botany, K. M. M. DAKSHINI.
University of Delhi,
Delhi-7, *September* 27, 1968.

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INFLUENCE OF INDUCED WATER STRESS ON CHLOROPHYLL COMPONENTS OF PROXIMAL AND DISTAL LEAFLETS OF GROUNDNUT PLANTS

FARKAS AND RAJHATHY[1] observed increased chlorophyll content under drought conditions. However, Virgin,[2] Thompson *et al.*[3] and Jayarami Reddy[4] reported a decreasing trend in wheat, turnips and groundnut respectively. The present study relates to the changes in the chlorophyll components due to water stress in the proximal and distal leaflets.

Groundnut plants (variety: TMV-4) were raised in soil cultures (soil: compost, 3:1) in earthen pots (12″ × 12″). At the age of 45 days, water stress was induced (by stopping watering to the soil) till about the permanent wilting stage (*i.e.*, wilted leaves showed no recovery overnight). For proper comparison, control plants with optimum watering were maintained simultaneously. The field or pot capacity and wilting coefficient of the soil were 18·5% and 4·8% respectively on oven-dry weight basis following the procedure described by Piper.[5] Leaf sampling was done from control and wilted plants in triplicates at 10 a.m. from the proximal and distal leaflets of the second leaf from the top. Chlorophyll *a*, *b* and total were estimated quantitatively according to Arnon's method[6] and the results are expressed on unit area basis as reported earlier.[7] Standard errors are computed and utilised to find out the differences between any two means by applying *t* test.

TABLE I

Influence of water stress on chlorophyll components (mg. per 1 dm.^{2} leaf area)

(Mean of three replications)

	Proximal leaflets		Distal leaflets	
	Control	Wilted	Control	Wilted
Chlorophyll *a* ..	1·26 ±0·035	0·94 ±0·015	1·31 ±0·012	0·84 ±0·027
Chlorophyll *b* ..	0·55 ±0·015	0·40 ±0·006	0·57 ±0·012	0·36 ±0·015
Total chlorophyll ..	1·82 ±0·049	1·33 ±0·020	1·89 ±0·023	1·21 ±0·042
Chl. *a*/Chl. *b* ..	2·29 ±0·015	2·35 ±6·039	2·30 ±0·036	2·33 ±0·042
Water content (% on oven dry weight)	74·5 ±0·50	48·8 ±0·46	75·0 ±0·67	47·0 ±0·43

The chlorophyll components and their ratios show little difference between the leaflets of the control plants. With water stress, the levels of chlorophyll *a*, *b* and total decreased significantly, without altering the *a*/*b* ratio and is in conformity with previously reported observations.[2-4] The possibility of decrease in chlorophyll contents during water stress, according to Meyer *et al.*,[8] could be not only due to inhibition of chlorophyll synthesis but also to accelerated disintegration of chlorophyll already present. The inhibition of chlorophyll synthesis may be due either to the blocking of protochlorophyll forming mechanism[2] or to protein loss.[3] A significant lowering of the pigments *a* and *b*, and apparently total pigment, was also observed in the distal leaflets of the wilted plants compared to the respective proximal ones of the wilted plants. The present study thus shows that water stress results in considerable decrease in the leaf chlorophyll, particularly from the distal leaflets of groundnut plants.

This investigation was carried out incidentally in the research project on 'Drought resistance in crop plants' financed by Indian Council of Agricultural Research.

Dept. of Botany, A. JAYARAMI REDDY.*
S.V. University College, I. M. RAO.
Tirupati, *October* 23, 1968.

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* Present address: Agricultural College, Bapatla (Andhra Peadesh).

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RESISTANCE OF RHIZOBIA TO ANTIBIOTICS

IN certain areas antibiotic production in the soil appears to be a major factor in legume establishment.[4] This would also mean that certain antibiotics, if produced *in situ* by soil micro-organisms, will be inimical to the establishment and biological activity of *Rhizobium*. Reports on the reaction of rhizobia toward antimicrobial agents are few.[2,5,6,9,12] The present note reports the relative sensitivity of five rhizobial species to four antibiotics.

R. meliloti (*Medicago sativa*), *R. leguminosarum* (*Pisum sativum*), *R. phaseoli* (*Phaseolus mungo*), *R. japonicum* (*Glycin max* and *R.* sp. (cowpea group) (*Phaseolus aureus*) among rhizobial species and graded concentrations of sodium penicillin G (Squibb), streptomycin sulphate (Merck, Sharp and Dohme), chloramphenicol (Park-Davis) and terramycin (Pfizer) among antibiotics were used. Resistance or sensitivity was determined by double layer plate count method at each concentration level in yeast extract-mannitol agar medium.

Table I shows that while *R. meliloti* was fairly resistant to high levels of penicillin (LD > 100 µg./ml.), *R. phaseoli* was sensitive above 5 µg. drug/ml. Concentrations above 25 µg./ml. were lethal to *R. leguminosarum* and *R.* sp., and above 10 µg./ml. to *R. japonicum*.

Streptomycin was lethal to *R. leguminosarum* and *R. phaseoli* at concentrations above 0·1 µ./ml., whereas the LD for *R. japonicum* and *R.* sp. was found to be above 0·5 µg./ml. and for *R. meliloti* above 5 µg./ml. (Table I).

R. leguminosarum and *R. phaseoli* were highly resistant to chloramphenicol (2000 µg./ml.). However, the drug was lethal to *R. phaseoli* at concentrations above 25 µg./ml. *R. japonicum* and *R.* sp. were, however, resistant upto 250 µg. drug/ml. (Table I).

While *R. japonicum* and *R.* sp. were resistant upto 10 µg. terramycin/ml. (34·5% survival), concentrations above 0·05 µg. were lethal to *R. phaseoli*, above 0·2 µg. to *R. meliloti* and above 0·5 µg. to *R. leguminosarum* (Table I).

TABLE I

Comparative lethal levels of antibiotics (µg./ml.) for Rhizobium *spp.*

	R. meliloti	*R. leguminosarum*	*R. phaseoli*	*R. japonicum*	*R.* sp.
Penicillin ..	> 100	> 25	> 5	> 10	> 25
Streptomycin ..	> 5	> 0·1	> 0·1	> 0·5	> 0·5
Chloroamphenicol ..	2000	2000	>25	>250	>250
Terramycin ..	> 0·2	> 0·5	> 0·05	> 10	> 10

Although the application of antibiotics in relation to the classification of micro-organisms has been indicated,[3,7,8,10,11] it will be rather unsafe to use this criterion in the case of *Rhizobium*.

We are grateful to Dr. W. V. B. Sundara Rao for his interest and to Dr. R. B. Rewari for the *Rhizobium* cultures. One of us (C. L.) is grateful to the Director, Indian Agricultural Research Institute, for awarding a Fellowship during the tenure of this work.

Division of Micro-biology,
I.A.R.I., New Delhi-12,
October 23, 1968.

C. L. Chopra.
G. S. Venkataraman.

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A NOTE ON DRECHSLERA ROT OF TOMATO

During September-December 1965, the authors observed a severe storage rot of tomato fruits in the local vegetable market. Consistent isolations from the diseased fruits invariably yielded *Drechslera australiense* (Bugn.) Subram. and Jain, which was confirmed from Commonwealth Mycological Institute, Kew, England. The culture has been deposited at C.M.I., Kew, as No. 13182 and in the Botany Department, University of Allahabad. It was found to be pathogenic as it fully satisfied Koch's[1] postulates. No species of this genus has so far been reported on fruits of *Lycopersicon esculentum* Mill from any part of the world, hence it appears to be a new host for the above organism.

Symptoms.—In the beginning small chætura black[2] lesions are produced by the pathogen. They are circular and water soaked. Subsequently they enlarge from the point of infection, become darker and develop black-coloured spore masses of the fungus. The junction between the diseased and healthy tissue remains clearly defined (Fig. 1). The size of the spots in older fruits increases and the decay penetrates deeply into the flesh. Only injured fruits can be infected by the organism as uninjured fruits failed to develop any symptoms.

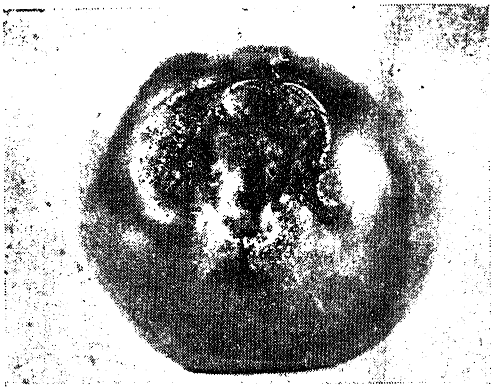

Fig. 1

The fungus grows well on Asthana and Hawker's Medium 'A' at 25° ± 1° C. In culture the mycelial colony is white but becomes grey at maturity. Hyphæ are septate, 2–6 μ, conidiophores are straight or curved, septate; conidia are mostly 4-celled (3-septate), light grey in colour and measure $8 \cdot 75$–$21 \times 5 \cdot 3$–$7 \cdot 0\ \mu$.

Extensive cross-inoculations were carried out and it was observed that the organism could infect the fruits of guava (*Psidium guajava* L.), brinjal (*Solanum melongena* L.), mango (*Mangifera indica* L.), apple (*Pyrus malus* L.), banana (*Musa paradisiaca* L.), chilli (*Capsicum annum* L.), bean (*Dolichos lablab* L.), pea (*Pisum sativum* L.) and radish (*Raphanus sativus* L.). It, however, failed to infect orange (*Citrus aurantium* L.), emblic myrobalan (*Phyllanthus emblica* L.), carambola (*Averrohoa carambola* L.) and tubers of potato (*Solanum tuberosum* L.). Suitable control were maintained in all the cases.

We are grateful to Dr. M. B. Ellis of C.M.I., Kew, England, for the help in final identification of the fungus and to the Ministry of Education for the award of a Scholarship to one of us (I. J. K.).

Department of Botany, I. J. KAPOOR.
Allahabad University, R. N. TANDON.
Allahabad (India),
September 28, 1968.

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OCCURRENCE OF PETALOID STAMENS IN *GOSSYPIUM BARBADENSE* LINN.

THE occurrence of petaloid bracts, sepals, stamens and stigma is observed in plant kingdom. In cotton, Sankaran (1931) reported petaloid stamens in Asiatic cotton (*G. arboreum*), wherein the entire staminal column of the flowers was transferred into a petaloid structure. The petaloidy here was observed to be the transformation of primordia of the stamens into petals and this phenomenon added support to the recognition of the foliar nature of the stamens. Rhyne (1965) has recorded the occurrence of reduced andrœcium in cotton which was controlled by cytoplasmic inheritance.

At the Regional Research Station, Kovilpatti, one plant in *G. barbadense* (Russian variety 504-B) was observed to produce a few flowers with petaloid stamens. It was interesting to note that the same plant produced flowers with normal stamens as well as petaloid stamens. On close examination of the petaloid flowers it was found that only a few of the stamens ranging from two to four in number were involved (Fig. 1).

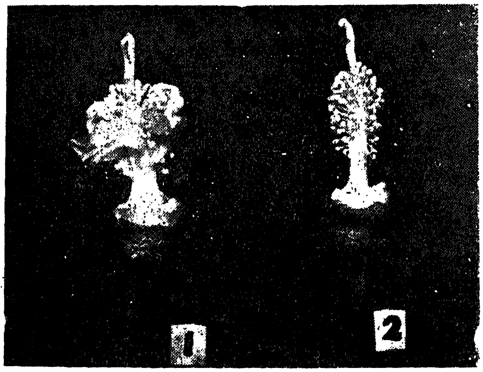

FIG. 1. (1) Petaloid. (2) Normal.

Pollen grains from normal and petaloid flowers were collected separately and tested for viability through artificial medium (Table I).

TABLE I

Sl. No.	Nature of flower	No of pollen grains			Viability %
		Total examined	Fertile	Sterile	
1	Flower with petaloid stamen	247	11	236	4·5
2	Normal flower ..	259	247	12	95·4

It would be seen from Table I that the pollen grains from the petaloid flowers are almost sterile as compared to fertile pollen of the normal. When the pollen dust from normal flowers was applied on the stigma of the flowers with petaloid stamens, fertilization was effected. The seeds produced from such "crosses" were sown and the progenies studied for two generations. None of them produced flowers with petaloid stamens. It was clear from this observation that petaloidy in this case was not heritable in contrast to Rhyne's (1965) observations on cotton.

It was also observed that the formation of petaloid stamens in this case was not due to pathogenic causes. Thus, the first occurrence of partial petaloid stamens in *G. barbadense*, observed in this station, might have been caused by physiological cause.

The help given by Shri P. A. Mohamed Ibrahim, Crop Specialist, in writing this note is gratefully acknowledged.

Regional Res. Station, O. RAMANATHA PILLAI.
Kovilpatti, V. D. GURUSWAMY RAJA.
June 26, 1968.

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SURVIVAL OF MAIZE SEEDLINGS UNDER STRESS OF PLANT COMPETITION

DIFFERENCES in plant competition between different genotypes have been noticed under mixed planting. In most investigations differences in the ability of various genotypes to suppress or compensate the yield of another genotype have been reported.[1,2] In the present study using the same maize variety (open-pollinated) in which early seeding was followed by late interplanting, the competitive ability of various genotypes under mixed planting was measured in terms of post-emergence survival or plant stand at maturity (Table I).

The experiment was laid out with four treatments in three replications in R.B. design.

TABLE I

Treatment	Germination (%)	Survival after emergence (%)	Plant stand at maturity (%)
1. All seeded (early) ..	68·2	68·2	60·5
2. do. (late) ..	79·4	79·4	65·1
3. Alternate seeded (late) (with early seeded)	72·7	36·7	25·2
4. Alternate seeded (late) (with transplant)	63·1	40·4	30·8
C.D. at 5% ..	NS	15·7	10·5

(NS = Not significant.)

30 hills were planted in each plot. Distance from hill to hill was one foot with rows two feet apart. Under treatment-1, all hills were seeded early (August 19) whereas under treatment-2, all hills were sown late (September 11). Treatment-3 comprised of two dates of sowing in the same plot: early sowing (August 19) in alternate hills followed later by second sowing (September 11) in the remaining hills. Under treatment-4, alternate hills were transplanted with seedlings sown in August 19; the remaining hills were seeded. Both seeding and transplanting were done on the same date (September 11).

Seed germination was more or less the same in all the treatments (Table I). Seeding (early or late) without mixed planting (treatment-1 and 2) did not show any reduction in plant stand after emergence. However, under mixed planting, second seeding in an early seeded plot (treatment-3) or in competition with transplanted seedlings (treatment-4) resulted in 50 to 64% reduction in plant stand due to post-germination seedling mortality. Such high seedling mortality observed only in alternate seeded (late) under mixed planting may be attributed to greater susceptibility of the seedlings in question to diseases which found more favourable ground for expression under the stress of early-sown seedling competition. Similar observation on smut incidence in barley was made by Doling[3] who showed that differences in number of smutted ears per plot could arise when the seed rate was markedly raised and consequently the competitive factor between seedlings in the different plots was very different.

As expected, plant stand at maturity reflected the same trend as noticed under survival after emergence. It appears that delayed interplanting in an early seeded population of maize may help to screen genotypes having superior competitive ability.

Division of Genetics, N. N. ROY.
Indian Agricultural
Research Institute,
New Delhi-12, *October* 1, 1968.

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MEIOSIS IN TWO POLYMORPHIC SPECIES OF *PENNISETUM*

Pennisetum pedicellatum Trin. and *P. polystachyon* Schult. are wild grasses native to Africa. Both the species show polymorphism and there are cytological races within the species. The plants for the present study were raised from seeds obtained from Kenya, through the courtesy of the officer-in-charge of the Grassland Research Station, Kitale, and from Ghana through the courtesy of Dr. J. K. Morton, University College of Ghana, Achmiota, to both of whom I offer my sincere thanks.

Pennisetum pedicellatum Trin.—There are at least two chromosomal races in this species The material from Kenya showed the chromosome number $2n = 36$ and the material from Ghana has $2n = 54$, thus one is a tetraploid and the other a hexaploid. Morphologically these two forms could be distinguished, the hexaploid being more robust, with larger and thicker inflorescences, woolly bristles bein more prominent than in the tetraploid form In the tetraploid forms the inflorescences ar more deep-coloured than in the hexaploid. Th hexaploid showed abundant proliferation; th spikelets had turned into vegetative structure and looked like bulbils. Arber writing o proliferations in plants belonging to the fami *Gramineæ* says that these structures seldo develop into new plants.[1] To test this, fif of these proliferated spikelets when the developed to the maximum size on the infl rescences were collected and planted in po More than 50% of these grew into matu plants. The proliferations seem to be effective method of vegetative reproduction this form. No such proliferations we observed in the tetraploid form.

The types of chromosomal associatio observed at diakinesis in the tetraploid a hexaploid forms are presented in Table and the data on chiasma frequencies a presented in Table II. The meiosis was regu and there was good seed-set.

TABLE I

Chromosome associations in pollen mother cells at diakinesis in 2 species of Pennisetum

	Associations						Total number of cells examined
	VI	V	IV	III	II	I	
P. pedicellatum ($2n=36$)							
Total number of associations ..	..	..	17	9	305	15	20
Means ..	..	..	0·85	0·45	15·25	0·75	..
P. pedicellatum ($2n=54$)							
Total number of associations ..	17	..	29	12	764	31	32
Means ..	0·53	..	0·90	0·38	24·00	0·97	..
P. polystachyon ($2n=36$)							
Total number of associations ..	..	..	29	1	297	7	20
Means ..	..	..	1·45	0·05	14·85	0·35	..
P. polystachyon ($2n=54$)							
Total number of associations ..	12	..	17	2	536	24	23
Means ..	0·54	..	0·74	0·08	23·30	1·04	..

TABLE II

Chiasma frequency in 2 species of Pennisetum

Species	Number of cells examined	6 Xta	5 Xta	4 Xta	3 Xta	2 Xta	1 Xta	Number of Xta per nucleus	½ Xma
P. pedicellatum ($2n=36$)	10	..	..	9	2	56	118	28·2	1·56
P. pedicellatum ($2n=54$)	17	5	..	19	10	193	154	39·8	1·48
P. polystachyon ($2n=36$)	10	..	..	15	..	32	120	24·4	1·40
P. polystachyon ($2n=54$)	13	7	1	15	..	95	172	39·1	1·44

Pennisetum polystachyon Schult.—From Ghana three seed samples were received out of which one showed to be a tetraploid with chromosome number $2n = 36$ and the other two are hexaploids with $2n = 54$. Dr. Morton while sending the seed informed me that in nature this species shows polymorphism. In culture here also the hexaploid was more robust. The plants raised from seed obtained from Kenya are all hexaploids ($2n = 54$). Thus in this species also there are at least two chromosomal races.

The types of chromosomal associations observed at diakinesis in both the forms are given in Table I and the chiasma frequencies in Table II. The meiosis was regular and the seed-set was good in this species also.

The evidence obtained from the study of meiosis and the morphology of the forms point to the fact that in all probability the polyploidy in both the species is autopolyploidy. The morphological variations within the species seem to be associated with chromosome numbers, the higher polyploids (hexaploids) being more robust than their tetraploid relatives. It is interesting to note that in the seed samples got from both the sources there were no diploid forms. What the condition in nature is not known but from the present observations it may be tentatively stated that perhaps the tetraploids and hexaploids are more vigorous and hence they are more successful in their distribution range when compared to their diploid relatives. If diploids are in existence they must be having a more restricted distribution under more congenial conditions.

I am thankful to Prof. J. Venkateswarlu for the facilities and encouragement.

Department of Botany, J. V. PANTULU.
Andhra University,
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VIABILITY OF GAMETES WITH DEFICIENCY-DUPLICATION IN LINSEED (*LINUM USITATISSIMUM* L.)

THE viability of spores with deficiency-duplications is well known.[1-3] The functioning of deficiency-duplication spores in an organism furnishes a method of locating genes already placed. In the course of gene-localisation studies in linseed (*Linum usitatissimum* L.) using chromosomal translocations such a viability of gemetes with deficiency-duplication was observed. Six interchange homozygotes, *viz.*, RT 5, 7, 46, 52, 71, 73 and NPRR. 10, the variety with standard chromosomal arrangement from which the interchange homozygotes were derived by radiation were crossed with five cultivated pure breeding types providing contrasting characters of flower and seedcoat pigmentation. Hybrids were produced and the plants in the segregating generation F_2 were screened for pollen sterility, indicative of heterozygosity for translocated chromosomes and the respective seedcoat and flower parts pigmentations.

A striking feature of the hybrids was their relative low sterility (Table I). In an interchange heterozygote one would normally expect 50% pollen sterility.[4] In these cases the high pollen fertility has been attributed to the higher frequency of alternate segregation and the relative short segments of chromosomes involved in the interchange, precluding crossing overs in the interstitial segments. In the present material detailed cytological examinations have revealed low occurrence of alternate segregation, *viz.*, ranging from 0·6 to 26·6%.[5,6] If, however, the segments involved are short the deficiencies could be tolerated by the organism. The presence of this phenomenon was indicated by the fact that the pollen abortion in most of the interchange heterozygotes was low notwithstanding the relatively low occurrence of configurations leading to alternate segregation in first anaphase of meiosis. It would be interesting to see whether this inference is supported by evidences from studies other than pollen abortion.

TABLE I

Pollen sterility of the different F_1 hybrids of the crosses involving interchange homozygotes and the different genetic tester stocks

Tester stocks / Interchange homozygotes		NP 8	NC 12–1	NP (H) 54, Sabour yellow	NP 11
RT 5	..	24·29	20·11	19·21	27·27
RT 7	..	33·33	23·20	24·28	38·78
RT 46	..	26·92	21·14	22·10	35·22
RT 52	..	20·00	29·12	18·75	51·16
RT 71	..	13·24	23·45	12·76	44·47
RT 73	..	20·32	22·19	19·21	40·00
NPRR 10	..	2·46	5·11	3·03	3·66
S Em	..	±2·401	..	..	..
*'F' value	..	2·036	..	Not significant	

* For calculation, hybrids of NP 11 were not considered since the data were collected in off-season. Data from NP 8 NC 12–1 and NP (H) 54—Sabour Yellow—were collected in the regular season.

Two evidences that indicate the functioning of gametes with deficiency-duplication are: (1) the occurrence in F_1 plants of some recessive phenotypes on account of "pseudodominance", and (2) the occurrence in the F_2 of an excess of recessive phenotypes than expected when compared to the normal. In the present material the first evidence was not observed since all the F_1 hybrids exhibited true dominance for the characters under consideration, *viz.*, petal and seedcoat pigmentation. In the study of F_2 population as particularly in the cross between interchange stock 5 and NP 8, one of the varieties used in the study, the sterile class recorded an excess of recessives (Table II). Similar observations on excess of recessives in the progeny of deficiency-duplication heterozygous stocks was observed in *Triticum monococcum* for characters 'early' and 'argentina'.[1] Such a functioning of deficiency-duplication spores has been noted to be fairly common in interchanges which give mostly chain-forming configurations in the heterozygotes as in the case of T 1-6 b in maize.[3] In the present material also fairly a high frequency of chains or 'U' or 'V'-shaped configurations have been noted. Additional evidences are thus provided for the viability of deficiency-duplication. The viability of deficiency-duplication which has been noticed even in diploid organism like *T. monococcum* is only to be expected in any organism like linseed which is suspected to be a polyploid.[7]

TABLE II

Joint segregation in the F_2 population for petal colour and pollen sterility in crosses involving NP 8

Material		Frequencies of individuals F_2				X^2_1 for linkage	'P' lies between
		Fertile		Sterile			
		Blue	White	Blue	White		
Interchange: stocks							
RT 5	..	9	6	9	9	0·818	·50 and ·3
RT 7	..	20	10	39	7	3·438	·10 and ·0
RT 46	..	32	9	23	13	1·909	·20 and ·1
RT 52	..	47	19	34	14	0·011	·95 and ·9
RT 71	..	37	11	31	14	0·806	·50 and ·3
RT 73	.	33	16	43	15	0·526	·50 and ·3
Standard							
NPRR 10		70	25	0	0	..	..

Genetics Division,
Indian Agricultural
Research Institute,
New Delhi, *October* 31, 1968.

K. SENGUPTA.*
S. S. RAJAN.

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* Soybean Breeder, Central Vegetable Breeding Substation, P.O. Katrain, Dt. Kulu, Himachal Pradesh.

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REVIEWS AND NOTICES OF BOOKS

Proceedings of the Seminar in Fluid Mechanics. Edited by P. L. Bhatnagar (Director of the Seminar). (Department of Applied Mathematics, Indian Institute of Science, Bangalore-12), 1968. Pp. 480. Price Rs. 34·50.

The subject of Fluid Mechanics received an enormous impetus from the development of aerial flight and the movement of aircraft at high speeds. Indeed, the number of mathematical problems to which a theorist can address himself at the present time is very large. In this field of activity, there has been considerable interest displayed by various Indian centres of study, amongst which may be mentioned a few, *viz.*, the Department of Applied Mathematics, Indian Institute of Science, Bangalore-12, Department of Aeronautical Engineering in the same Institute, the National Aeronautical Laboratory, Bangalore, The Indian Institute of Technology, Powai, Bombay, and the Departments of Mathematics at various Universities in India.

As a result of these developments, it appeared desirable to organise a Seminar to bring together the workers in this field of Fluid Mechanics. This was held at the Indian Institute of Science, Bangalore, from May 24 to May 30, 1967. The volume under review reproduces many of the papers presented to Seminar. It appears in two sections, *viz.*, Newtonian Fluids and Non-Newtonian Fluids. Twenty-three reports appear in Section A and fifteen reports in Section B. Each of these sections starts with a report by Dr. P. L. Bhatnagar who was the Director of the Seminar.

The Seminar was sponsored by the University Grants Commission, Government of India. The volume may be commended for bringing together in a convenient form the work that is being done at various places in India. It will be found useful by those working in the field.

C. V. R.

Annual Review of the Microbiology (Vol. 22). Edited by C. E. Clifton. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. vii + 596. Price $8.50 in U.S.A. and $9.00 elsewhere.

Volume 22 of this well-known series contains the following articles: Prefatory Chapter: The Lure of the Unknown, by William H. Taliaferro; The Fine Structure of Blue-Green Algæ; Ecology, Physiology, and Biochemistry of Blue-Green Algæ; Biology and Physiology of Coccolithophorids; Cell-Wall Chemistry, Morphogenesis, and Taxonomy of Fungi, Biochemical Peculiarities of Trypanosomatid Flagellates; The Ecology of Transferable Drug Resistance in the Enterobacteria; Bacterial Cytochromes; Foot-and-Mouth Disease; Cholera Toxins; Toxins Produced by Fungi; On the Mechanism of Immunity—In Defense of Evolution; Replication of RNA Viruses; Microbiology of Winemaking; The Poxviruses; The Oncogenic DNA Viruses: A Review of *In Vitro* Transformation Studies; Metabolism of Animal Cells Infected with Nuclear DNA Viruses; Lysogeny: The Integration Problem; Energy-Coupling Mechanisms in Chemolithotrophic Bacteria; Mathematics of Microbial Populations; and Other Reviews of Microbiological Interest.

C. V. R.

The Elementary Functions. By Fleenor *et al.* (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1, England), 1968. Pp. ix + 293. Price 65 *sh.*

This text is designed to provide the necessary foundation for a standard calculus course. Because calculus is concerned with the properties of functions and with operations on them, it is vital that students be familiar with the non-calculus aspects of functions beforehand. In particular, this text treats those elementary functions that are differentiated and integrated in calculus. These include polynomial, exponential, logarithmic, and trigonometric functions, and their combinations. Moreover, the continuity and increasing or decreasing character of these functions are discussed in a way that serves as a foundation for later use of calculus methods. The treatment of these topics conforms to the recommendations of the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America.

The titles of the chapters contained in this text are: Relations and Functions; Polynomials; Properties of Functions; Exponential and Logarithmic Functions; The Circular Functions; Numerical Trigonometry; Analytic Trigonometry; Analytic Geometry in the Plane;

The Conics; Analytic Geometry in Space; and Other Co-ordinate Systems. C. V. R.

Elementary Differential Equations. By Kreider, D. L. *et al.* (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1968. Pp. xiv + 492. Price 102 *sh.*

The aim of the authors of this book is to present their subject in the context of linear algebra, and in a style suitable for mathematics majors and non-majors alike. Applications are emphasized and much of the theory included may be omitted if desired.

Content areas include vector spaces and linear transformations, matrices, first-order differential equations, *n*th-order linear differential equations, Green's functions for initial-value problems and Laplace transforms, systems, separation and comparison theorems, series solutions, existence theorems, and an introduction to stability theory. The book assumes the prerequisite of a first course in differential and integral calculus. C. V. R.

Introduction to the Theory of Relativity. By Sears and Brehme. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1, England), 1968. Pp. vii + 216. Price 61 *sh.*

This book uses a mathematics-through-geometry technique to solve a large number of problems in relativity with both ease and clarity. The authors use Galilean and Lorentz geometric diagrams to simplify descriptions of Einstein's relativity theory. Included are detailed solutions to many famous "paradoxes". The philosophical and metaphysical aspects of relativity are not discussed. The first four chapters, concerned with the relativistic treatment of space and time, can also be used as a supplement to a general physics course.

C. V. R.

ANNOUNCEMENTS

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Physics to Sri. Y. Anantarama Sarma; Ph.D. degree in Geophysics to Sri. R. Ramakrishnayya; Ph.D. degree in Chemistry to Sri. V. Anjaneyulu.

The M.S. University of Baroda has awarded the Ph.D. in Chemistry to Sri. U. K. Jagwani and Sri. Mahesh Jayantilal Mehta; Ph.D. degree in Statistics to Sri. Shantilal Mangaldas Shah.

Osmania University has awarded the Ph.D. degree in Chemistry to Sri. R. Vittal Rao; Ph.D. degree in Botany to Kumari P. Mayura Devi; Ph.D. degree in Zoology to Sri. M. Shah Baz Khan and Kumari Sunita Devi Singh.

Sri Venkateswara University has awarded the Ph.D. degree to the following in subject noted against each: Sri. S. A. T. Venkatachari (Zoology); Sri. G. S. Mahaboob Hussain (Zoology); Sri. K. Srirama Rao (Botany), Sri. B. Saiprasada Rao (Geology); Smt. M. Sugunamma (Mathematics).

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Wave Propagation in a Turbulent Medium. By V. I. Tatarski. (Dover Publications Inc., New York, N.Y. 10014), 1968. Pp. xiv + 285. Price $ 3.25.

Quantitative Chemistry Measurements and Equilibrium. By W. B. Guenther. (Addison-Wesley Pub. Co., Inc., London W. 1), 1968. Pp. xv + 400. Price 91 *sh.*

Reduction Techniques and Applications in Organic Synthesis. By R. L. Augustine (Marcel Dekker, Inc., New York 10016) 1968. Pp. ix + 242. Price $ 12.75.

Introduction to Chemistry. By A. L. Williams H. D. Embree and H. J. Debey. (Addison-Wesley Pub. Co., London W. 1), 1968 Pp. xx + 712. Price 65 *sh.*

Physics for Chemists and Biologists. By D. O Hughes and J. L. Latham. (Butterworth Co., London W.C. 2), 1968. Pp. ix + 367 Price 52 *sh.* 6 *d.*

British Ecological Society Symposium (No. 8)—*The Measurement of Environmental Factor in Terrestrial Ecology.* Edited by R. M Wadsworth. (Blackwell Scientific Pub Oxford, England), 1968. Pp. x + 314. Pric 55.00 *sh.*

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DISEASES OF TEA, COFFEE AND RUBBER DISCUSSED AT THE FIRST INTERNATIONAL CONGRESS OF PLANT PATHOLOGY

V. AGNIHOTHRUDU

Technical Adviser, Rallis India Limited, Fertilizers and Pesticides Division,
6-A, Cunningham Road, Bangalore-1

THE First International Congress of Plant Pathology was held from 14th to 26th July 1968, at the Imperial College of Science and Technology, London and was attended by over 1,200 delegates from all over the world. The following is a brief account of the papers presented on plantation crops, particularly Tea, Coffee and Rubber which may be of some use to research workers of these plantation crops in India.

TEA

Dr. Kerr and Dr. de Silva of the Tea Research Institute of Ceylon presented a paper on the Blister Blight of tea. According to them, Blister Blight was first recorded in Ceylon, in 1946 and it spread subsequently to all planting districts, causing serious damage to the tea, particularly during active monsoon at altitudes of 1500 feet and above. The disease is spread by wind-borne spores, which show a marked diurnal fluctuation in number, the spore release being dependent on high atmospheric humidity.

Disease incidence in Ceylon is rated by the 3rd leaf method, and significant damage occurs when the infection rate is over 35%. The disease is controlled by 7 to 10 day rounds of copper fungicide sprays, during monsoon periods and it is estimated that 30 to 35 rounds per year are not uncommon. But theoretically, as few as four rounds may be adequate in some years. Two major factors increase the disease incidence, *viz.*, the number of spores landing on susceptible leaves and the duration of the leaf wetness. The former is directly correlated with the number of spores in the atmosphere and can be predicted if the current level of infection and mean daily sunshine during incubation and sporulation are known. Daily sunshine is negatively correlated with the leaf wetness and is more convenient to use for disease forecasting and predicting. By judiciously combining sunshine records with measured or estimated spore numbers, disease incidence can be accurately predicted. Disease forecasting cannot cover extensive areas in Ceylon because of variable climatic conditions over relatively short distances. Because of this, a simple calculating device was discovered to enable individual estates to forecast disease incidence. The utility of these methods for forecasting disease under South Indian and North-East Indian conditions need be investigated.

Dr. C. S. Venkataram of the UPASI Tea Experimental Station dealt with the developments in spraying technique and the control of Blister Blight. A large number of fungicides have been screened but with the exception of Daconil, no organic fungicides or antibiotics controlled Blister Blight effectively at economic rates of usage, because of poor tenacity. Fungicides are generally sprayed as water suspensions or solutions on tea. Oil as a carrier is not generally recommended due to the problems involved in tainting. Dusting has its limitations. The frequent heavy showers wash away the dust making dusting less effective than spraying. Until 1960, only protectant copper fungicides were in vogue. In South India, the trend is gradually shifting from protective copper spraying to the use of nickel chloride, which is claimed by Dr. C. S. Venkataram to be an eradicant.

The use of nickel, according to him, has the added advantage of exerting very little influence on the build-up of mite pest in tea, whereas copper is reported by UPASI research workers to stimulate the population of mites, especially the purple mite and the red spider. As nickel is supposed to have a systemic action, it is not fully known what happens to the nickel which goes into the plant system. As nickel is washed away from the surface of the plants by rain, its fate in the soil is also quite obscure at this stage. The search for a fungicide with systemic action against Blister Blight has not been fully rewarding. Soil treatment with nickel salts and derivatives of oxathiin resulted in systemic disease control of potted tea plants, but proved impractical on a field scale. On the other hand, systemic control of Blister Blight on young plants was achieved with a foliar spraying of oxathiin under laboratory conditions, but in the field similar treatment was found not effective.

Dr. Shanmughan Nathan of the Tea Research Institute of Ceylon presented a paper on the parasitism and control of the tea root disease fungi. Root diseases are quite serious on tea plantations in Ceylon. As in South India, the most serious one is Red root rot caused by *Poria hypolateritia*. Besides the above, Charcoal Stump rot (*Ustulina deusta*), Brown root rot (*Fomes noxius*) and Black root rot (*Rosellinia arcuata*) also occur. Red root rot disease alone has destroyed over 1000 acres of tea in the country and continues to spread both in the old and new plantings. Heretofore, these diseases have been controlled by laborious and expensive digging and removal of infected roots and subsequent replanting. The efficacy of these practices vary. The recent discovery that soil fumigation with methyl bromide at ½ lb for every 100 sq. feet is very effective in eradicating these pathogens, promises a great improvement in root disease control. Other benefits like, vigorous growth of tea following fumigation, have been reported.

Poria hypolateritia does not produce viable air-borne spores in Ceylon and only known sources of inoculum are the infected roots of tea or the shade trees, only a small amount of which is said to infect young tea plants. In South India the fructifications of the fungus have been noticed on tea. It would be of interest to see whether they occur on the jungle vegetation also. It is regrettable that very little work on the basidiomycetes has been done in this part of our country. It is observed that the pathogen (*P. hypolateritia*) can survive for long periods in infected root tissues and still retain its infectivity. Infection generally occurs by root contact and by growth of mycelium through the soil. Colonization of root system is confined to the top 30" in soil.

Ustulina deusta spreads mainly by air-borne spores produced on infected shade tree stumps. Ring barking of shade trees has proved to be a useful means of reducing disease outbreaks by reducing stump infections.*

COFFEE

Drs. Nutman, Griffiths and Vine have discussed the Coffee Berry Disease in East Africa, which is now widespread in Kenya. There can be few, if any, areas where Coffee Berry Disease does not occur. In 1967, losses in some plantations amounted to not less than 80 to 90% and loss for the country as a whole has been estimated at about 30%. The reason for considerable increase in the severity is largely climatic according to them. There was much heavier than average rainfall in 1967 and it was more uniformly distributed throughout the year. The fungus *Colletotrichum coffeanum* produces its spores on the bark at the onset of the rains.

Both spore production and infection can be significantly reduced by application of fungicide before the rain, but with the present rainfall pattern, secondary spread from spore production of infected berries leads to rapid build-up of disease in the period after the rains. The situation is aggravated by the widespread occurrence of multiple flowering (running blossom). Young developing crop as well as ripening berries from a previous flowering may co-exist on the tree. When such a situation arises together with favourable conditions for spread and infection, ripe berries which are very susceptible become infected producing large number of spores and this may lead to heavy loss in the crop.

Effective control now seems to demand a break in the cycle of overlapping crops and reinforcement of the pre-rain sprays (designed to reduce the spore load on the bark) with protectant spray in the period after the rains. With the result, fungicides for the control of Coffee Berry Disease should ideally eliminate or reduce spore production from infected bark, provide adequate protection to the developing berries, be effective in controlling the leaf disease caused by *Hemileia vastatrix*. It will be interesting to note the great similarity in the spraying schedule of the Coffee Berry Disease and the leaf disease.

Coffee berries take about 9 months to mature and for most of this time, they are highly susceptible to infection. Spores are water-borne and infection occurs most frequently during the rainy season. Spraying at these times with tractor-mounted equipment is often extremely difficult and hence the fungicide with high biological persistence and resistance to weathering is required. Captafol (Difolotan) seems to be one of the most useful of the commercially available fungicides and used for extensive field trials. Laboratory methods for evaluating fungicides in the control of Coffee Berry Disease have been developed which show good correlation with field performance. Using these methods a large number of products have been screened, a few appear particularly promising. As a result of Coffee Berry Disease becoming increasingly serious pre-long-rains spraying will have to be supplemented by post-rains spraying and Captafol [N-(1, 1, 2, 2-Tetra Chloro ethyl thio) Cyclohex-4-ene-1, 2-dicarboximide] is considered to be highly suitable for such a programme.†

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* Investigations in North-East India have revealed that *Ustulina* in most instances infects through unhealed wounds.

RUBBER

Drs. Wastie and Chee of the Rubber Research Institute, Kuala Lumpur, dealt with problems on the chemical control of diseases of *Hevea* rubber in Malaysia. Formerly the chemical control of diseases of rubber in Malaysia was largely confined to mouldy rot (*Ceratocystis fimbriata*) on the tapping panel and *Pellicularia salmonicolor* (Pink disease) on branches. However, 20 years of extensive planting in mono-clone blocks of high-yielding selections has been followed by an increase in the severity of the diseases above ground. In a re-appraisal of control techniques of *P. salmonicolor,* it was stated that Bordeaux mixture, though effective, cannot be used on tapping cuts because of the danger of copper contamination of latex. Moreover, the fungicide has got to be applied at frequent intervals. A more tenacious formulation based on paranitrophenol seems to have overcome this disadvantage. Leaf fall caused by *Oidium* and *Colletotrichum glœosporioides* severely affects the growth of certain clones. Sulphur dusting against *Oidium* has increased yield and vigour of a highly susceptible clone. Control of *Colletotrichum* remains an intractable problem, largely because of physical difficulty of obtaining good coverge of fungicide on the foliage of mature trees. The seedling leaf disease caused by *Helminthosporium heveæ,* the effects of which have become very significant as a result of changing budding techniques, has effectively been controlled by carbamate fungicides particularly Zineb and Maneb. Outbreaks of *Phytophthora* leaf fall in the last two years have necessitated the exploration of control techniques. Tapping panel infection by the same pathogen can be controlled with tin or mercury based fungicides, but high mammalian toxicity seems to pose problems.

The developments in the last few years of the fungicidal dressing as a prophylactic treatment against root disease, has filled a long-standing gap. The active ingredient (Quintozene) is highly active against the principal root pathogens (*Fomes lignosus*) but not against *Ganoderma pseudoferreum* though there is a promise that a formulation effective against both these fungicides will be found ultimately.

Dr. Chee reported variability in *Phytophthora* isolates from rubber in Malaysia. Morphological and physiological studies, spore size, spore production, pairing characteristics, cardinal temperatures for growth, colony development on solid nutrient substrata have been made with more than 250 *Phytophthora* isolates causing disease on rubber in Malaysia and Thailand. Differences in morphology and pathogenicity of the isolates are considerable. Their classification into species and strains was attempted. Rubber, cocoa, and an atypical strain of *P. palmivora* are recognised. They show the greatest variation among or within the strains. Most isolates from leaves, pods and twigs are more uniform and resemble *P. meadii,* but differ in having exceptionally smaller sized sporangia. All but few isolates from the leaves, pods and twigs, comprising strains of both species in culture, produce sporangia in great abundance and in clumps conspicuously visible to the naked eye when grown in light illumination. Black stripe of the tapping panel and patch canker of untapped bark are associated with less freely sporing strains of *P. palmivora* throughout W. Malaysia, but in areas affected by leaf fall, black stripe may be caused by the other species. The distribution of strains follows a geographic pattern, anomalous or non-complementary strains are found in areas where both complementary strains co-exist.

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† In the light of Coffee Berry Disease occurring in East Africa, the New Malady of Coffee in South India was discussed with the East African workers and while the question of pathogen particularly *Colletotrichum* being involved has not been over-ruled, Drs. Nutman and Griffiths have suggested that further work should be carried out, particularly on the saprophytic and parasitic strains of *Colletotrichum* of coffee occurring in South India. The rapid sporulation of several fungi including *Colletotrichum* following the first rains in March–April reveal a striking similarity to the Coffee Berry Disease. The fact that thorough spraying on coffee ameliorates the New Malady of coffee in South India to a certain extent, leaves one to doubt whether the condition is only purely physiological.

It is essential to investigate the role of several strains of *Colletotrichum* which begin sporulating immediately after first showers on the setting of the berries. Dr. Nutman is of the opinion that the strains of *Colletotrichum* which produce the *Glomerella cingulata* stage may be purely saprophytic and pathogenicity trials should be largely concentrated on the imperfect strains of the fungus.

Dr. O. S. Peres of Vidyodaya University, Ceylon, discussed the economics of control of *Fomes lignosus* in Ceylon. According to him, *Fomes lignosus,* being a weak parasite, must have a food base from which it will spread to infect the healthy tree. Expenditure on the eradication of food bases prior to replanting has been found to be economically sound. An analysis of labour requirements for disease control and the growth of young rubber after treatment for *Fomes* control has proved that the periodical examination of the root system of every tree, for infection though practical, is uneconomical.

Treatment on the basis of leaf symptoms, that is, at an advanced stage of infection is feasible. The use of fungicides for control of the disease is not warranted in both cases. The use of prophylactic methods which prevent reinfection of treated trees and those adjacent to them, is justifiable.

Addition of small quantities of sulphur to the soil at the time of planting, lowers the soil reaction, encourages growth of saprophytic *Trichoderma viride* and reduces incidence of *Fomes* infection. For economic reasons, this treatment should be confined to areas which are known to be heavily infected with *Fomes* prior to replanting. It is concluded that the most economical method of controlling *Fomes* at present is to plant at a slightly higher density than that required at the time of maturity and to eradicate *Fomes* infected trees as a part of routine thinning out operations. Transplanting should be done only to prevent too uneven a stand. Sulphur can be added to the soil profitably at the time of planting in areas known to be heavily infected.

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I am thankful to Dr. S. D. Garrett, F.R.S., of the Botany School, Cambridge, for kindly inviting me to participate in the First International Congress of Plant Pathologists and to Rallis India Limited for making my trip possible.

SOLUTE-VACANCY INTERACTION IN ALUMINIUM-ZINC-SILVER ALLOYS

K. S. RAMAN, E. S. DWARAKADASA AND K. I. VASU

Materials Research Group, Department of Metallurgy, Indian Institute of Science, Bangalore-12, India

ABSTRACT

Electrical resistivity measurements have been used to follow the isothermal ageing of Al–4·4% Zn, Al–4·4% Zn–0·03% Ag and Al–4·4% Zn–0·08% Ag alloys. Vacancy-Silver atom-binding energy has been evaluated as 0·15 eV at 0° C.

INTRODUCTION

INTERACTION between the two types of defects—solute atoms and vacancies—in metals has been the subject of study in recent years. These interactions are of great importance in evaluating the mechanism of atom transport in age hardening alloys, particularly aluminium base alloys. Although the influencing parameters are many, attempts have been made to discuss the ageing process in terms of an interaction between the supersaturated thermal vacancies and solute atoms. It is now widely accepted that in the decomposition process following the quench vacancy-type defects play a very dominant role. Study of this type of interaction gives rise to the concept of a binding energy, E_B^{v-i} between the vacancy and the solute atom.[1] The different energy terms that contribute to the binding energy have been discussed in detail.[2] Some theoretical estimates are available, but E_B^{v-i} for a number of solutes in Al matrix have been determined experimentally by several workers,[3–11] and different methods of evaluating this term have been discussed.[2] Since the electrical resistivity of a metallic specimen is sensitive to the nature and distribution of point defects, the best estimate of this interaction energy is made by following the changes in electrical resistivity immediately after the quench.

On going through the literature we found that there existed a considerable discrepancy in the reported values of binding energy for different elements in Al matrix. In trying to read order into these values (E_B^{v-Mg} in Al) Perry[11] suggested certain convincing refinements in experimental procedure and analysis of results. In the absence of a well-developed theory to explain the exact physical significance of the binding energy, it becomes necessary to evaluate this term for different metals by separate experiments. Also it is said[12] that any explanation put forward on the basis of results on a given alloy need not necessarily hold good for others. We therefore proposed to work on a few ternary aluminium alloys containing silver and this paper summarises the results obtained with Al-Zn-Ag alloys with 0·03 and 0·08 at.% silver. Silver was chosen because even small addition of this element seems to exert an appreciable influence on the ageing process in, and properties of, age-hardenable alloys based on Al-Zn system.[13]

THEORETICAL

The anomalous increase in resistivity observed in quenched Al-rich alloys is associated with the cluster-forming process. This is a vacancy-aided process and has been used to study the kinetics of the precipitation process, and in particular to study the vacancy-impurity interaction. The finding that the presence of a small quantity of a third solute influences the clustering rate of a binary alloy, has been used by many to evaluate the vacancy-solute binding energy. The basis for such an evaluation has been discussed by Hashimoto[4] and Perry.[11] In general, the time taken to reach the peak in resistivity in binary and ternary alloys is dependent on the quenched-in free vacancy concentration. Hence the ratio of the times-to-peak in the two alloys is a measure of the difference in quenched-in vacancy concentration; in other words it is an index of the binding energy of the ternary solute with vacancy. The ageing ratio can be expressed as:

$$\text{Ageing ratio} = \frac{(\text{Time-to-peak})_{\text{Ternary}}}{(\text{Time-to-peak})_{\text{Binary}}}$$

$$= \frac{1 - 12X_{zn} - 12X_{Ag} + 12X_{zn}\,\text{exp.}\left(\frac{E_B^{v-zn}}{kT_a}\right) + 12X_{Ag}\,\text{exp.}\left(\frac{E_B^{v-Ag}}{kT_a}\right)}{1 - 12X_{zn} + 12X_{zn}\,\text{exp.}\left(\frac{E_B^{v-zn}}{kT_a}\right)} \qquad (1)$$

This equation assumes two important requirements, *viz.*, that in the quenched alloy vacancies and solute atoms are singularly distributed, and that the nature of equilibrium distribution at T_q and the distribution immediately after quench must be similar. That this is not so in practice[10] introduces some limitations to the accuracy of the results obtained. These have been discussed by Perry.[11] An analysis of this type has been shown to give a reasonable value for v-Mg binding energy in an Al-Zn-Mg alloy. Hence assuming a good order of accuracy we evaluated the E_B^{v-Ag} in Al-Zn-Ag alloys. We also evaluated the E_B^{v-Be} value in an Al-Zn-Be alloy[14] which behaved very similar to Al-Zn-Mg alloys.[11]

EXPERIMENTAL

Super pure Al (99·997%), high purity Zn (99·99%) and Ag (99·99%) were used to make the alloys by melting and casting in a purified Argon atmosphere, to obtain cylindrical ingots 200 mm. long and 10 mm. in dia. After homogenization, the ingots were rolled in several stages, with intermediate annealing at 400° C. to wires 2–3 mm. dia. and then cold-drawn to wires 0·7 mm. in dia. Three alloys were made for the study and the compositions are given in Table I.

TABLE I

Compositions (at.%) of the alloys used

Alloy	Zn	Ag	Al
1	4·280	0·000	Remainder
2	4·388	0 027	,,
3	4·395	0·079	,,

Two meters of the alloy wire was cut, and 50 cm. on either ends were rolled into a flat ribbon, which were split in two so as to serve as current and potential leads, thus avoiding contact resistance and thermo emf effects. The middle I meter portion was wound into a helical coil 3 cm. long and 1 cm. in dia. These coils were first stabilized, then solutionized at a temperature of 320° C. for 1 hr., quenched into stirred ice/water mixture at 0° C., and aged continuously at that temperature. Resistivity changes were followed by the standard 4-probe potentiometric technique, and the resistivity values recorded directly at the ageing temperature. Since the specimen was connected to the measuring circuit even during homogenization the first reading after the quench could be taken within 3-5 seconds and subsequent readings taken at intervals of 5 seconds. The absolute value of the resistance of the coils was in the range 0·09–0·098 ohm. The slight error thought to be introduced due to the self-inductance of the coil was found to be of negligible order of magnitude.

RESULTS AND DISCUSSION

Changes in resistivity during isothermal ageing after quench from 320° C. to 0° C. of the three alloys, are shown in Fig. 1. The relative time-to-peak in the binary and the ternary alloys is an index of the binding energy of vacancies to the ternary solute atom. This is evaluated using Eq. (1) in which the vacancy-Zn binding energy is to be known with precision. Many values of this were available in literature,[1,11,15,16] but it is to be noted that the value depends on many factors such as purity of metals used, quenching temperature, specimen size and quenching rate, and concentration of Zn in the alloy. Even small amounts of the impurity present in super pure aluminium have been reported to give rise to measurable binding energy effects.[17] We therefore had to evaluate the v-Zn binding energy for experimental conditions used by us. This we did by obtaining the quenched-in resistivity values of the binary alloy at 0° C. and determining the formation energy of vacancies in the alloy from a plot of log ($\Delta\rho$) $vs.$ $1/T_q$.[1] This plot was obtained for 3 different wire sizes (0·9, 0·8 and 0·7 mm.), and the values of formation energies were related to specimen diameters,[18] to get the apparent formation energy by extrapolating the values to zero specimen size. This extrapolation also includes correction for the quench-clustering effect[11] and for any vacancy loss during quenching. By comparing this corrected formation energy with that in pure Al (which is 0·76 eV)[19] we obtained an effective v-Zn binding energy of 0·06 eV. This is in good agreement with that obtained by Perry[11] and Panseri and Federighi.[1]

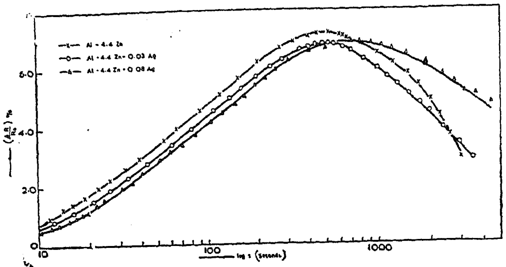

FIG. 1. Isothermal ageing curves of Al–4·4% Zn, Al–4·4% Zn – 0·03% Ag & Al – 4·4% Zn – 0·08% Ag alloys quenched from 320° C. and aged at 0° C.

The possible effects of association of Zn atoms amongst themselves, and of the influence of silver atoms on the zone forming process, indicated by a smaller peak height for the ternary alloys in Fig. 1 can be corrected by extrapolating the time to achieve given fractions of the peak back to zero time of ageing.[9] This has been done for the two alloys in Fig. 2, and using the corrected ageing ratios, and the 'effective' v-Zn binding energy of 0·06 eV, the v-Ag binding energy was found to be 0·15 eV. Some values of E_B^{v-Ag} available in literature have been compared with our present value in Table II. Alloys used and the method employed by other authors have also been indicated therein.

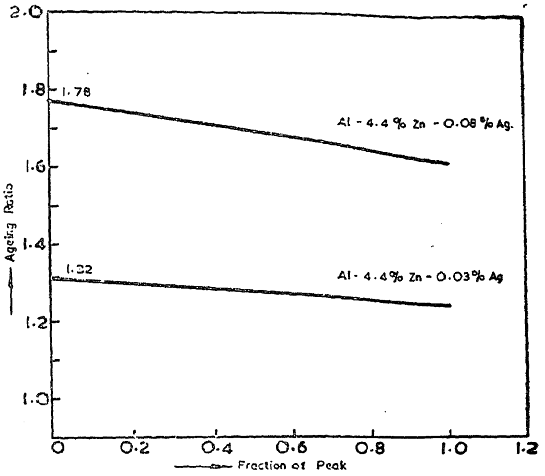

FIG. 2. Ageing ratio *vs.* fraction of peak for the 2 ternary Al–Zn–Ag alloys.

TABLE II

Vacancy-Silver atom binding energies in aluminium matrix

Alloy composition at. %	Method	E_B^{v-Ag}	Reference
Al-Ag (6, 9, 12)	..	0·4	(20)
Al-Ag (0·52, 0·94)	LE	0·08	(21)
Al-Ag (0·768)-Sn (0·0023) Al-Ag (0·768)-In (0·0024) Al-Ag (0·768) Ge (0·0038)	CR	0·25	(4)
Al-Zn (6·844)-Ag (0·277)	H	0·1	(22)
Al-Zn (4·388)-Ag (0·0345)	CR	0·2	(7)
Al-Zn (4·388)-Ag (0·037) Al-Zn (4·395) Ag (0·079)	CR	0·15	Present work

LE : Simultaneous measurement of differential length and lattice parameter. CR : Clustering rate. H : Hardness measurements.

The data in Table II show that the E_B^{v-A} values depend very much on the alloys use and the experimental conditions. Shee, Wah and Misra[22] obtained a value of 0·1 eV on th basis of hardness results on Al-6·844% Zn 0·277% Ag alloy, in which both Zn and A concentrations are higher than ours. Th influence of increasing concentration is t reduce the value of binding energy.[9] Als while even the time-to-peak in resistivity which takes place in a few minutes after th quench, is influenced by the presence of Ag atoms (by influencing the lifetime of a vacancy), the time-to-peak in hardness, which appears after 100–1000 minutes, does give rise to an overestimate of the formation energy and hence leads to a lower value of binding energy. The differences between our value and other values therefore stems mainly from differences in experimental procedure and analysis of results. Our conditions closely resemble those of Ohta *et al.*[5–7] but, it is possible that the efficiency of quench is greater in our experiments. Also, Ohta *et al.* have computed the value of E_B^{v-Ag} by using known binding energy values for the ternary atoms added to Al-Ag alloys. This again might introduce some differences. Thus, we are of the opinion, that the vacancy-silver binding energy in Al matrix is close to our value of 0·15 eV. This also agrees with the result of Westmacott *et al.*[23]

Further Eq. (1) suggests that using results obtained by ageing at different values of T_a one can evaluate the dependency of binding energy on temperature. We have calculated this, after quenching from 320° C., and found that the value is sensitive to T_a; it decreases with temperature. Another fact that may not be apparent from Eq. (1) is the effect of varying the solutionizing temperature T_Q. In the alloys we studied, values of $E_B^{v\ Ag}$ do vary for different T_Q but same T_a. But Hashimoto[4] did not observe any such dependency.

While the concept of using an effective binding energy term for the predominant solute atom seems to be quite convincing we feel that the value will be influenced by the type of ternary solute added, and the nature of interaction between the two solute species. In particular, when the ternary solute added is itself capable of clustering predominantly, its influence will be strong. That this is so can be seen from the large slope of plots in Fig. 2. The slope for the higher concentration of Ag is greater than that for the lower concentration. In order to get a better estimate of the binding energy, the concentration must be kept as small as possible, of the order of 0·001 at.% as was done in the case of Mg.[11] We are now working with this end in view.

ACKNOWLEDGMENT

Our thanks are due to Dr. S. Dhawan, Director, Indian Institute of Science, and Professor A. A. Krishnan for their interest in this work, and to other members of the Materials Research Group for their willing co-operation.

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LETTERS TO THE EDITOR

FLOW BETWEEN ECCENTRIC CYLINDERS

THE steady flow of a viscous fluid between eccentric cylinders, when the inner cylinder of radius R_1 is rotating while the outer of radius R_2 is stationary, is investigated under the narrow-gap approximation. This problem is of practical interest in the lubrication theory, particularly in the liquid bearing system.

Let (α, β, z) be the eccentric cylidrical co-ordinates where R_1 and R_2 correspond to $\alpha = \alpha_1$ and $\alpha = \alpha_2$ respectively.

Let

$$\psi = \frac{R_2 - R_1}{R_2} = \frac{C}{R_2} = \frac{\sinh \alpha_1 - \sinh \alpha_2}{\sinh \alpha_1} \tag{1}$$

$$\epsilon = \frac{\sinh (\alpha_1 - \alpha_2)}{\sinh \alpha_1 - \sinh \alpha_2} \tag{2}$$

be the clearance and eccentricity ratios where we assume $\psi << 1$. The problem is assumed to be two-dimensional with components of velocity U and V in the directions of α and β respectively. The rotation of the inner cylinder with velocity V_0 is the sole cause of the flow. Then the required equations, following the analysis of Ritchie (1968), are:

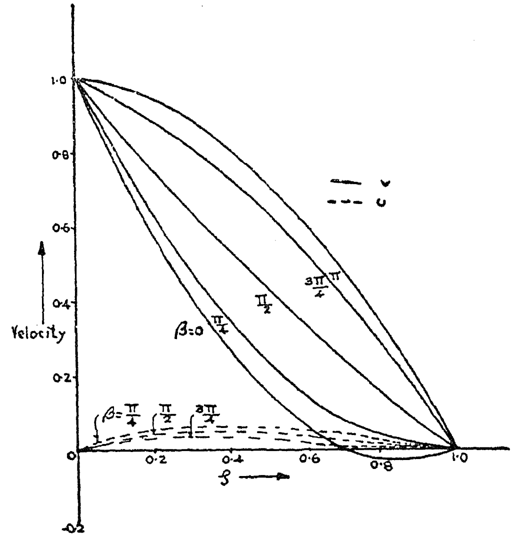

FIG. 1. Velocity Profile

$$\frac{\partial p}{\partial \zeta} = 0 \tag{3}$$

$$\frac{\partial^2 v}{\partial \zeta^2} = RH\psi (1 - \epsilon^2) \frac{\partial p}{\partial \beta} \tag{4}$$

$$H \frac{\partial u}{\partial \zeta} + \frac{\partial}{\partial \beta}(Hv) = 0 \tag{5}$$

where

$$U = V_0 tu,\ V = V_0 v,\ P = \rho V_0{}^2 p,$$

$$h = R_2 H = \frac{R_2 (1 - \epsilon^2)^{\frac{1}{2}}}{1 - \epsilon \cos \beta},\ R = \frac{V_0 C}{\nu}$$

$$t = \psi (1 - \epsilon^2)^{\frac{1}{2}},\ \zeta = \frac{\alpha - \alpha_1}{t},\ \nu = \frac{\mu}{\rho} \tag{6}$$

μ is the coefficient of viscosity, p is the pressure and R is the Reynolds number which is assumed to be finite. In our analysis we assume that $\partial p/\partial \beta$ is of $0\,(1/\psi)$.

The boundary conditions are

$$u = 0 \quad \text{at} \quad \zeta = 0, 1 \tag{7}$$

$$v = 1 \quad \text{at} \quad \zeta = 0 \tag{8}$$

$$v = 0 \quad \text{at} \quad \zeta = 1 \tag{9}$$

and u, v, p are periodic in β. The solutions of (3) to (5) using (7) to (9) are

$$u = \frac{\epsilon \sin \beta}{1 - \epsilon \cos \beta} \zeta (1 - \zeta)^2 \tag{10}$$

$$v = (1 - \zeta) \left[1 - 3\zeta \left\{1 - \frac{2 (1 - \epsilon \cos \beta)}{2 + \epsilon^2}\right\}\right] \tag{11}$$

$$p - p_0 = \frac{6 \epsilon \sin \beta}{R\psi (1 - \epsilon^2)^{3/2} (2 + \epsilon^2)} (2 - \epsilon^2 - \epsilon \cos \beta) \tag{12}$$

where p_0 is the static pressure.

If τ is the shearing stress, then

$$\tau = \frac{\mu V_0}{a} \left[\frac{\partial}{\partial \alpha} v \cosh \alpha - v \cos \beta) + t \frac{\partial}{\partial \beta} (u \cosh \alpha - u \cos \beta)\right] \tag{13}$$

where a is the distance of the pole from the origin.

If C_i and C_0 are skin friction coefficients at the inner and outer cylinders respectively,

$$C_i = \frac{2 (1 + 3\epsilon \cos \beta + 2\epsilon^2) (\cos \beta - \cosh \alpha_1)}{t (2 + \epsilon^2)} + \sinh \alpha_1 \tag{14}$$

$$C_0 = \frac{2 (1 - 3\epsilon \cos \beta - \epsilon^2) (\cos \beta - \cosh \alpha_2)}{t (2 + \epsilon^2)} \tag{15}$$

We found (as shown in Fig. 2) that the velocity component in the radial direction is much less than the velocity component in the azimuthal direction. The pressure is found to decrease with increasing Reynolds number. However the corresponding magnetohydrodynamic results (which we have submitted for publication elsewhere) show that the pressure increases with increasing the Hartmann number and hence the magnetic field makes the flow more stable.

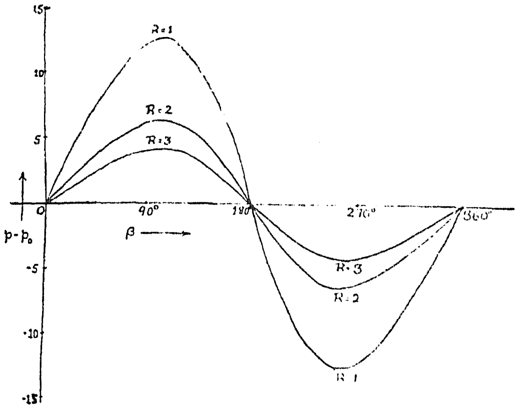

FIG. 2. Pressure Distribution

Post-Graduate Studies
in Mathematics,
University College of Engg.,
Bangalore University,
Bangalore, *December* 12, 1968.

N. RUDRAIAH.
M. G. GEETHA.

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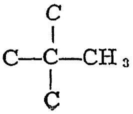
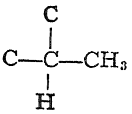
THE STRUCTURE OF BROMO-OXOISHWARONE

X-RAY diffraction data from a suitable crystal of Bromo-oxoishwarone were obtained with copper radiation. The crystal belongs to the monoclinic space group P 2_1 with two molecules of $C_{15}H_{21}O_2$ Br in a unit cell of dimensions

$$a = 9{\cdot}29\ \text{Å},\ b = 6{\cdot}99\ \text{Å},\ c = 12{\cdot}10\ \text{Å and } \beta = 113°\ 24'.$$

The structure of the molecule was obtained from the (010) electron density projection (Fig. 1).

The molecule contains three rings—two six-membered chairs and one five-membered ring. It has two  $\mathrm{C{-}\overset{\displaystyle C}{\underset{\displaystyle C}{C}}{-}CH_3}$ groups and one  $\mathrm{C{-}\overset{\displaystyle C}{\underset{\displaystyle H}{C}}{-}CH_3}$ group as shown in the molecular configuration in Fig. 2.

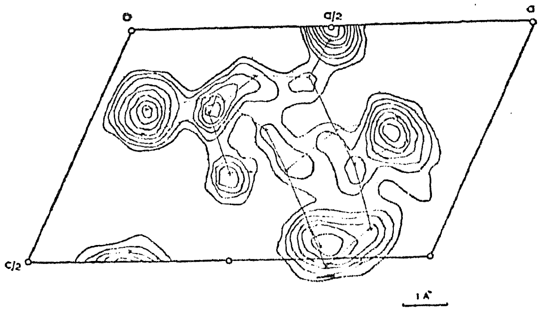


FIG. 1. (010) electron density projection of Bromo-oxoishwarone.

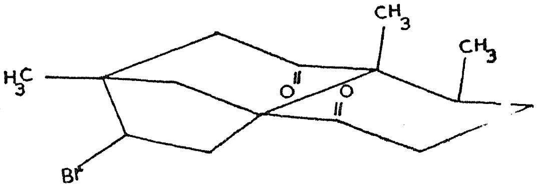


FIG. 2. Molecular configuration of Bromo-oxoishwarone.

The atomic co-ordinates in the (010) projection are given in Table I. An average isotropic temperature factor of 10·0 Å^2 has been used for all atoms. The unusually large temperature factor accounts for the absence of any reflections beyond $\theta = 45°$. The R-factor is 0·17. Diffraction data at low temperature $-150°$ C are being collected for refinement of the crystal structure.

TABLE I
Atomic positions in fractional co-ordinates

	x co-ordinate	z co-ordinate
Br	0·127	0·172
C 1	0·285	0·145
C 2	0·445	0·215
C 3	0·145	0·230
C 4	0·285	0·185
C 5	0·360	0·105
C 6	0·500	0·105
C 7	0·625	0·225
C 8	0·545	0·315
C 9	0·405	0·315
C 10	0·710	0·300
C 11	0·820	0·440
C 12	0·750	0·520
C 13	0·670	0·440
C 14	0·760	0·200
C 15	0·810	0·250
O 1	0·510	0·030
O 2	0·715	0·480

The authors are thankful to Dr. T. R. Govindachari, Director, Ciba Research Laboratories, Bombay, and Dr. S. Ramaseshan, Deputy Director, National Aeronautical Laboratory, Bangalore, for sending them the problem.

Indian Institute of Technology, Madras-36,
November 23, 1968.

S. SWAMINATHAN.
G. SREENIVASA MURTHY.

THE BAND SPECTRUM OF SILICON MONOIODIDE

EXISTING knolwledge on the band spectra of diatomic monoiodides of the IV B group elements—carbon, silicon, germanium and tin—is meagre. In the course of our recent investigations on the halide spectra of these elements a characteristic band spectrum attributable to the diatomic silicon monoiodide molecule has been discovered. The spectrum has been observed in emission by exciting a mixture of silicon and iodine vapours by R.F. discharge from a 1/2 K.W. oscillator. The colour of discharge was bluish-green. Figure 1 is the reproduction of the spectrum recorded on Fuess spectrograph on which some of the prominent bands are marked. The spectrum reveals about 30 bands extending from λ 5400 to λ 4800. The band heads appear sharp and are degraded towards longer wavelengths. The bands are analysed as belonging to two subsystems whose quantum formulæ are as follows:

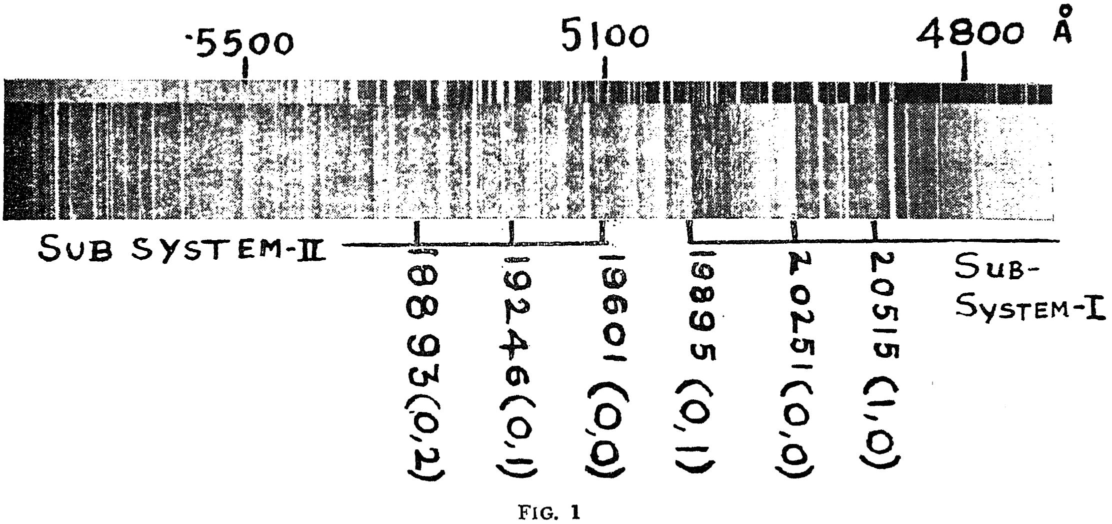


FIG. 1

Subsystem I

$$\nu_{(v'v'')} = 20294\cdot5 + 276\cdot3\ (v' + \tfrac{1}{2}) - 6\cdot0\ (v' + \tfrac{1}{2})^2 - 358\cdot8\ (v'' + \tfrac{1}{2}) + 1\cdot21\ (v'' + \tfrac{1}{2})^2$$

Subsystem II

$$\nu_{(v'v'')} = 19644\cdot2 + 276\cdot0\ (v' + \tfrac{1}{2}) - 5\cdot85\ (v' + \tfrac{1}{2})^2 - 358\cdot7\ (v'' + \tfrac{1}{2}) + 1\cdot57\ (v'' + \tfrac{1}{2})^2$$

The two subsystems arise from a common upper state with $\omega_e' = 276\cdot3$ to the different lower states of nearly equal vibrational frequencies. By analogy with the similar band systems of the other monohalides of silicon[1-3] the transition involved in the emission of this new doublet system is identified as the $A^2\Sigma^+ - X^2\Pi_r$ of the SiI molecule. An interval of 650 cm.$^{-1}$ is observed for the gound state $^2\Pi_r$ of the SiI molecule.

Detailes of the analysis will be published separately.

Spectroscopy Lab., Physics Department, Andhra University, Waltair, *January* 20, 1969.

A. LAKSHMINARAYANA.
P. B. V. HARANATH.

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FORCE CONSTANTS OF SOME ZINC BLENDE TYPE CRYSTALS

THE analysis of optically active lattice vibrations on the basis of GF matrix method as enunciated by Shimanouchi *et al.*[1] has recently been applied to some of the zinc blende type crystals.[2] In the present study a similar analysis has been carried out for Gallium and Indium compounds of zinc blende type structure to determine the force constants.

A zinc blende type crystal belongs to the space group Td^2-$F\bar{4}$ 3 m. Each Bravais unit cell of this type of crystals contains one formula unit—one zinc atom and one sulphur atom. The group theoretical considerations show that for zinc blende type there is only one fundamental lattice vibration, which is triply degenerate and active in both Raman and infrared absorption. The normal coordinate analysis gives only a combination of force constants.

$$k = K + 4\ H + 4\ H'$$

where K is the stretching force constant and H and H′ are the S–Zn–S and Zn–S–Zn bending force constants. The values of *k* obtained are given in Table I along with the lattice frequencies. H and H′ having only very small values will be negligible compared to K.

The stretching force constant K was calculated using Gordy's relation[3] for Gallium and Indium compounds,

$$K = 2 \cdot 25\ (\chi_A\ \chi_B/d^2)^{\frac{3}{4}} - 0 \cdot 20$$

where χ_A and χ_B are the electronegativity factors and d the bond length. These values are also given in Table I. The values of K calculated agree well within the value of *k* showing that the values of the bending force constants H and H′ are negligible. An inspection of the values in Table I also indicates that the force constants decrease in the order P → As → Sb in both Gallium and Indium compounds. This indicates that as the electronegativity of the atom decreases, the force constant decreases.

TABLE I
Force constants

Crystals		Frequencies cm^{-1}	k md/Å	K stretching force constant calculated from Gordy's relation md/Å
Ga P	..	367*	1·277	1·197
Ga As	..	273†	1·190	1·080
Ga Sb	..	231†	1·046	0·852
In P	..	307†	1·016	1·050
In As	..	219†	0·961	0·952
In Sb	..	185†	0·895	0·763

* Ref. 4. † Ref. 5.

One of us (V. U. N.) is grateful to C.S.I.R., New Delhi, for the award of a Junior Research Fellowship.

Dept. of Physics, V. UNNIKRISHNAN NAYAR.
Kerala Univ. Centre, G. ARULDHAS.
Ernakulam,
Kerala, *November* 7, 1968.

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SPECTROPHOTOMETRIC ESTIMATION OF URANIUM WITH 2-HYDROXY-1-NAPHTHALDOXIME

DURING the investigations on *o*-hydroxyoximes as inorganic analytical reagents the author found that 2-Hydroxy-1-Naphthaldoxime[1,2] gave the following reactions with: (*a*) uranium, an orange red colour at pH 9 to 11; (*b*) palladium, a pale yellowish precipitate in acid solution (pH 1), (*c*) vanadium, a green colour in acid medium (pH 2 to 4), (*d*) molybdenum, yellow colour in neutral as well as in acid medium (pH 2 to 7) and (*e*) iron, green colour at pH 3 to 5. The uranyl ions formed a stable orange red complex with the reagent in alkaline solution (pH 9 to 11) and the limit of identification was 3·6 γ at a dilution of 1 : 277,700 (*cf.* salicylaldoxime, 5 γ and 1 : 200,000).

REAGENTS AND APPARATUS

1. *Uranyl Nitrate Solution.*—Uranyl Nitrate (A.R.—B.D.H.) (ca. 1·2 gm.) was dissolved in water, acidified with dilute nitric acid and the solution diluted to 500 ml. and standardised.

2. A 0·05 M solution of the oxime in 95% alcohol was used as the reagent.

3. Absorption measurements were made with Hilger U.V. Speck Spectrophotometer with 1 cm. quartz cells. All pH measurements were made with Elico pH meter (Model LI-10A).

ABSORPTION SPECTRUM OF THE COMPLEX

4 ml. of the uranyl solution was treated with 5 ml. of the reagent solution and the pH maintained at values ranging from 7·0 to 11·0 by adding 0·1 N ammonia. The solution was diluted in a measuring flask to 25 ml. with 50% alcohol. Optical densities were measured at different wavelengths for each pH value and the values plotted in a graph. The region of maximum absorption was indistinct and the curve was flat between 470–475 mμ. Optical density was maximum and constant in the region of pH 9·0 to 11·0 at 470–475 mμ.

STANDARD CURVE FOR ESTIMATION OF URANIUM

A series of uranylaldoxime complex solutions in 50% alcohol was prepared having different concentrations of uranium by adding the reagent in excess (4 ml.). The pH was adjusted to be in between 9·0 and 11·0 with (0·1 N) ammonia and made up to 25 ml. The reagent treated with ammonia (light yellow solution) was used as the blank. Optical densities of these solutions were measured at 470 mμ. Beer's Law was obeyed in the concentration range, 0·5 to 5 mg./25 ml. (Fig. 1).

MOLAR COMPOSITION OF THE COMPLEX

Job's Method of Continuous Variation.—Equimolar solutions ($4 \cdot 25 \times 10^{-3}$ M) of uranyl ions and the ligand were prepared. A series of solutions was prepared by mixing x ml. of ligand with ($10-x$) ml. of uranyl solution (x varies from 1 to 10). The optical densities of these solutions were determined at 470 mμ. The absorption due to the component parts was negligible and therefore the corresponding densities were taken. The readings are given in Table. I.

TABLE I

S. No.	Vol. of uranyl solution (ml.)	O.D. at 470 mμ
1	1·0	0·180
2	2·0	0·221
3	3·0	0·227
4	4·0	0·224
5	5·0	0·190
6	6·0	0·150

The above results plotted in a graph (Fig. 2) show that the ratio of the metal to ligand is 1 : 2.

The author expresses his grateful thanks to Prof. K. Neelakantam for his guidance.

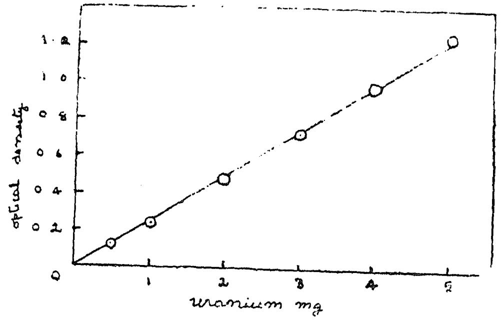

FIG. 1

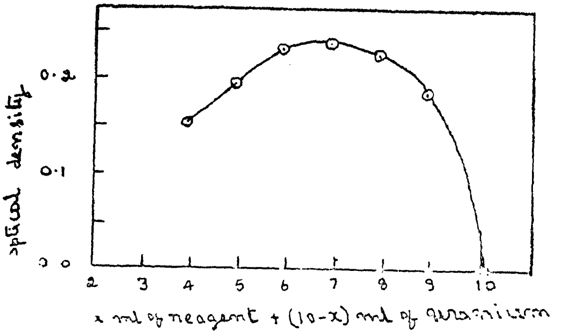

FIG. 2

Dept. of Chemistry,
Sri Venkateswara
University College,
Tirupati (A.P), *October* 23, 1968.

G. RAJA REDDY.

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THE KINETICS OF THE OXIDATION OF BENZYL ALCOHOL BY N-BROMO SUCCINIMIDE

ALTHOUGH NBS is known to be a versatil oxidising agent, very little kinetic work ha earlier been listed.[1] We have shown recentl that the kinetics of the NBS oxidations in aqueou acid solutions is generally complicated due to th liberation of Br_2 *in situ* and that this can b circumvented and pure NBS oxidation studie in the presence of added mercuric acetate The kinetics and mechanism of the oxidatic of secondary alcohols have been the subje of a recent study.[3] We present in this con munication certain interesting results on tl NBS oxidation of benzyl alcohol. The oxida tion was carried out in aqueous acetic acic perchloric acid mixtures and the kinetics w investigated by following the rate of di appearance of NBS by iodometry. The reacti is of the first order both with respect to NBS and alcohol. There is no complicating product oxidation especially under pseudo first order conditions (60% NBS is consumed in ca. 7 minutes in the oxidation of the alcohol while less than 2·5% of it is consumed in the oxidation of benzaldehyde in 45 minutes under identical conditions). The rate of oxidation is found to be totally independent of the concentration of mercuric acetate in the reaction mixture conforming to our earlier findings.

The reaction rate increases but slightly with increasing ionic strength (*e.g.*, when $\mu = 0{\cdot}1$, $k_2 = 9{\cdot}59 \times 10^{-3}$ and for $\mu = 0{\cdot}6$, $k_2 = 13{\cdot}1 \times 10^{-3}$ litre mole^{-1} sec^{-1}). The rate of oxidation is found to be dependent on the pH of the medium. Thus the second order rate constants for benzyl alcohol at $[H^+] = 1 \times 10^{-1}$, 1×10^{-2} and 1×10^{-3} M are $1{\cdot}3 \times 10^{-2}$, $1{\cdot}75 \times 10^{-2}$ and $2{\cdot}12 \times 10^{-2}$ respectively at 50° C. in 10% HOAc. At higher acidities, however, (0·5 M ~ 3M $HClO_4$) the reaction exhibits a linear relationship with H_0.

TABLE I

[Benzyl alcohol] = 0·08721 M [NBS] = 0·0012 M $\mu = 0{\cdot}1$
$[Hg(OAc)_2] = 0{\cdot}01266$ M Temperature: 50° C.

Solvent composition % HOAc	$k_2 \times 10^2$ litre mole^{-1} sec^{-1}
10	1·40
20	1·35
40	0·95
60	1·18

We also observe (Table I) that there is a small but progressive drop in the magnitude of the rate constants when the solvent is changed from 10% HOAc to 40% HOAc. In solvent mixtures containing a larger proportion of HOAc (i.e., > 40%) there is a small but definite rise in the magnitude. A similar trend was also observed by us in the oxidation of secondary alcohols[2] pointing to a dipole-dipole reaction. It is likely that in solvent mixtures containing larger proportions of acetic acid, the protonated form of NBS is the more reactive oxidant leading to an ion-dipole reaction. It must, however, be pointed out that there is practically no reaction in 100% acetic acid.

The reaction rate is profoundly affected by the introduction of electron-withdrawing substituents in the aromatic moiety. For example, a p-NO_2 group retards the rate by a factor of ≃ 22. (k_2 for the oxidation of p-nitro benzyl alcohol and benzyl alcohol are $6{\cdot}09 \times 10^{-4}$ and 135×10^{-4} litre mole^{-1} sec^{-1} respectively at 50° C. in 20% HOAc-80% H_2O [v/v]). The behaviour here seems to be analogous to bromine oxidations.[4]

Dept. of Chemistry, N. S. SRINIVASAN.
Vivekananda College, V. THIAGARAJAN.
Madras-4, N. VENKATASUBRAMANIAN.
November 7, 1968.

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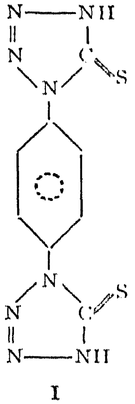
GRAVIMETRIC DETERMINATION OF SILVER WITH *p*-PHENYLENE-DI-(1-TETRAZOLINE-5-THIONE) (PDT-5)

THE use of 1-phenyltetrazoline-5-thione as the gravimetric reagent for the determination of silver has been reported[1] previously. In the present communication we report the analytical application of a difunctional tetrazoline-thione compound for a similar determination. The ligand used as the complexing agent is *p*-phenylene-di-(1-tetrazoline-5-thione) or 'PDT-5' (I). This ligand reacts quantitatively with Ag^+ ions in solution, forming a white, insoluble, 1 : 2 (ligand : silver) complex. This forms the basis of the gravimetric determination of silver.



I

All the reagents used were of AnalaR grade. The ligand was prepared by the method of Lieber and Slutkin.[2]

The following stock solutions were used:

(A) 'PDT-5' .... 0·2 g. in 100 ml. of warm acetone or 90% ethanol.

(B) $AgNO_3$ (dried at 120°) .... 0·4 g. in 250 ml. distilled water (this solution contained 1 mg. Ag^+ ions/ml.).

A known volume (1–20 ml.) of B was taken and diluted to about 50 ml. 4–6 drops of concd. HNO_3 were added followed by the addition of freshly filtered A (2 ml. for each mg. of Ag^+). The contents were stirred slowly with a glass rod. A voluminous white precipitate of silver complex immediately started accumulating down. After allowing to stand for 15–20 minutes, the precipitate was filtered in a medium porosity sintered glass crucible, washed first with 50 ml. of distilled water and then with 25 ml. of acetone or 90% ethanol. The precipitate was dried in a vacuum desiccator, and weighed as $Ag_2(C_8H_4N_8S_2)$. The white precipitate of silver complex sometimes darkened on drying, but this did not affect the results. The Gravimetric Factor for the 'silver : PDT-5' complex is 0·4386.

Similarly, more concentrated solutions of $AgNO_3$ (Ag content from 5–25 mg./ml.) were also analysed, and very satisfactory results were obtained. The results are shown in Table I.

TABLE I

Determination of silver with 'PDT-5' in homogeneous solutions

Sl. No.	Ag taken in soln. mg.	Wt. of Ag complex mg.	Ag recovered mg.	Error %
1	1·0	2·3	1·0	..
2	5·0	11·5	5·04	0·2
3	10·0	22·7	9·95	0·5
4	15·0	34·5	15·13	0·8
5	25·0	57·3	25·13	0·5
6	50·0	113·0	49·56	0·9

The analytical data in Table I reveal that 'PDT-5' can effectively be employed as a gravimetric reagent for the rapid determination of silver in solutions containing 1–50 mg. of the metal ions. Solutions containing $>$ 50 mg. Ag^+ ions are difficultly determined since the voluminous precipitate then requires a longer period of time to filter. The white silver complex is insoluble in water, acetone, alcohol, ether, pyridine, and hydrocarbons. Foreign cations such as Cu, Cd, Au, Rh, Ru interfere. Except CN^-, no other common anion interferes. The method gives best results when homogeneous solutions of silver are analyzed. A single determination of silver takes $\not>$ 1 hr.; the error is $\not>$ 0·5%.

Dept. of Chemistry,
Indian Institute of
Technology, Kanpur,
and
Dept. of Chemistry,
V.S.S.D. College,
Kanpur, *November* 5, 1968.

UMESH AGARWALA.
G. S. JOHAR.

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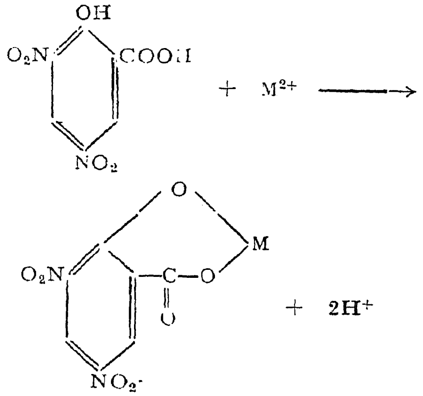
3, 5-DINITROSALICYLIC ACID AS A COMPLEX FORMING LIGAND

SOME results of study on the complexation of 3, 5-Dinitrosalicylic acid (3, 5-DNS) with bivalent metal ions like Ni (II), Co (II), Zn(II), Mn(II), Cd(II) and Mg(II), are reported in this note.

Potentiometric titrations of the mixtures containing metal and ligand in different ratios against standard alkali at 35 ± 0·2° C. in aqueous 0·1 M KNO_3 medium indicates the formation of 1 : 1 complexes (predominating in the pH ranges indicated against the systems in Table I), as under:



(1)

where M stands for the bivalent metal ions mentioned.

TABLE I

Sl. No	Systems	pH range	log K	$-\Delta F$ ° Kcal./mole.
1	Ni (II)-3, 5-DNS ..	4– 9	4·89	6·81
2	Co (II)-3, 5-DNS ..	4–10	3·88	5·50
3	Zn (II)-3, 5-DNS ..	4·5–8	3·70	5·25
4	Mn (II)-3, 5-DNS ..	3·5 8	2·95	4·18
5	Cd (II)-3, 5-DNS ..	5·5–8	2·85	4·04
6	Mg (II) 3, 5-DNS ..	6–9	2·65	3·73

The stability constants of the complexes were determined by applying the Calvin and

Melchior's[1] extension of Bjerrum's[2] method from potentiometric titration data. The overall change in free energy accompanying the reaction (1) has also been calculated applying the expression

$$\Delta F^{\circ} = - R\ T \ln K$$

where ΔF° is the standard free energy change, R is the gas constant and T the absolute temperature.

The results are summarized in Table I. The stabilities of the above complexes follow the Irving-William order[3]: $Ni^{+} > Co^{++} > Zn^{++} > Mn^{++} > Cd^{++} > Mg^{++}$. It is also observed that the stabilities of the above complexes vary approximately in a linear manner with electronegativity and ionisation potential of the metal ions, in accordance with the formulations of Van Uitert and co-workers.[4]

Thanks are due to the University Grants Commission for the award of a research scholarship to one of us (S. S. Dhindsa).

Department of Chemistry, Government College, Kota (Rajasthan), November 20, 1968.

S. S. Dube.
S. S. Dhindsa.

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CHEMICAL INVESTIGATION OF THE BARK OF *RHODODENDRON FALCONERI* HOOK.

Plants belonging to the genus *Rhododendron* (fam.: Ericaceæ) are known to possess medicinal and poisonous properties.[1] The leaves of *R. falconeri* were examined by Rangaswami and Sambamurthy.[2] The results of the chemical investigation on the bark are described here.

The bark powder (350 g.) was extracted successively with petroleum ether, chloroform and alcohol. The petroleum ether extract, on concentration to a low volume, deposited a crystalline residue which was filtered (fraction A). The residue obtained on evaporation of the filtrate, was saponified. The unsaponifiable matter, on treatment with acetone, yielded a white crystalline material (fraction B), which was filtered. Concentration of the filtrate gave a crystalline solid (fraction C). Fraction A was taken in chloroform-ether (1 : 3) and the solution was shaken with 2% sodium hydroxide. The precipitate that separated at the interphase was filtered (fraction A 1). The alkali-soluble and the alkali-insoluble fractions, recovered from the aqueous and the solvent layers respectively, did not yield any crystalline substance. A methanol solution of fraction A 1 was decomposed with acid, diluted with water and concentrated to a low volume. The precipitate that separated was filtered and dried. This was identified as betulinic acid—colourless needles from absolute alcohol, m.p. 299–302°, $[\alpha]_D = +5 \cdot 2^{\circ}$ (pyridine); acetate, m.p. 289–91°, $[\alpha]_D = +15 \cdot 5^{\circ}$; methyl ester (diazomethane); m.p. 225–26°, $[\alpha]_D = +9 \cdot 6^{\circ}$; methyl ester acetate, m.p. 195–96°, $[\alpha]_D = +14 \cdot 1^{\circ}$; methyl ester benzoate, m.p. 246–49°, $[\alpha]_D = +41 \cdot 3^{\circ}$. Confirmation of the identity was obtained from analysis, mixed m.p., superimposable I.R. spectra and identical colour reactions. Fraction B crystallised as colourless plates from chloroform: m.p. 275–76°; benzoate, m.p. 287–89°. The substance was identified as taraxerol which was confirmed from analysis, mixed m.p., superimposable I.R. spectra, and mixed m.p. of the benzoate. Fraction C was chromatographed over neutral alumina. The petroleum ether-benzene (19 : 1, 9 : 1, 4 : 1 and 1 : 1) eluates yielded taraxerol. The pure benzene eluate crystallised from benzene as colourless plates, m.p. 176–78°. The benzene-chloroform (19 : 1 and 9 : 1) eluates yielded colourless nodules from benzene, m.p. 210–12°. Due to very poor yields, work on the latter two substances could not be pursued further.

The chloroform extract was concentrated, diluted with ether and the resulting solution was shaken with 2% sodium hydroxide when a precipitate separated at the interphase. The interphase precipitate, on decomposition with acid, yielded betulinic acid. The identity was confirmed from colour reactions, m.p., mixed m.p., superimposable I.R. spectra and through the methyl ester (m.p. and mixed m.p.).

The alcohol extract, on vacuum concentration to a low volume, deposited a resinous solid which did not yield any crystalline material. The mother liquor was hydrolysed with 7% sulphuric acid and extracted with ether. The residue, recovered from the ether extract, was treated with dilute acetone. The yellow precipitate that gradually separated crystallised from dilute acetone, m.p. 296–99°. The substance was identified as quercetin by paper chromatography and through the complete methyl ether, m.p. 148–49°, the mixed m.p. of which with quercetin pentamethyl ether was undepressed. The hydrolysate, left after ether extraction, was neutralised with freshly precipitated barium carbonate, filtered and the filtrate evaporated to a residue. Paper chromatography of the residue (system : butanol - acetic acid - water—4 : 1 : 5) showed the presence of glucose and xylose.

Except betulinic acid, the yields of the other crystalline substances were rather low. The occurrence of taraxerol from the genus *Rhododendron* was first reported by Rangaswami and Hariharan.[3] All the rotations were taken in chloroform except where otherwise stated.

The authors thank Prof. S. Rangaswami for his kind interest and for the analyses. Their thanks are also due to Prof. L. R. Row for the I.R. Spectra.

Dept. of Pharmacy,
Andhra University,
Waltair (S. India),
November 1, 1968.

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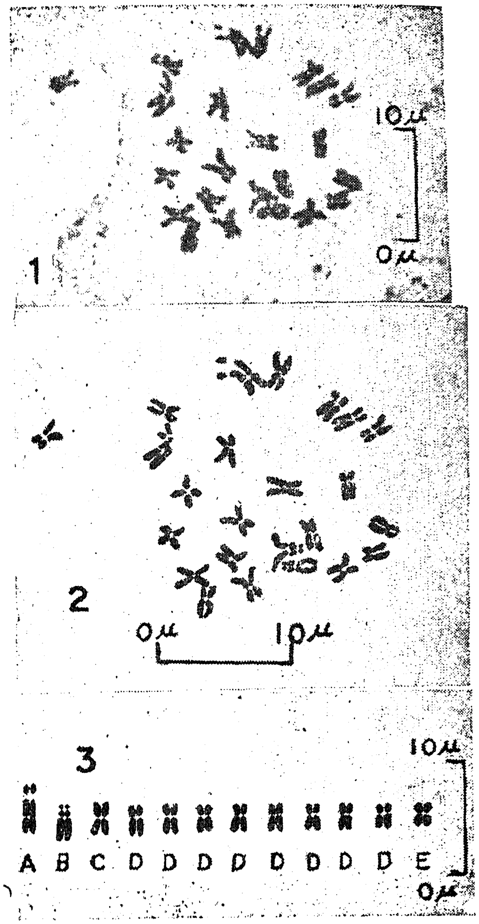
THE KARYOTYPE OF *SOLANUM ELAEAGNIFOLIUM* CAV.

Solanum elaeagnifolium Cav. is native to U.S.A. where it is a common weed in the southern and western states.[4] Seeds of this species were obtained from Coimbatore where the plant has been introduced recently. The chromosome number of the species has been reported as $n = 12$ from meiotic preparations.[3] The present note deals with its karyotype from mitotic preparations.

The root tips of seedlings were pretreated in a saturated aqueous solution of *p*-dichlorobenzene for two hours at 12–14° C., fixed in glacial acetic acid-alcohol mixture (1 : 2) and stained in aceto-orcein solution prior to squashing.[5] Observations were made on several spread-out metaphases. The $2n$ chromosome number was invariably 24 (Figs. 1 and 2). No accessory chromosomes were observed such as have been reported by Chennaveeraiah and Krishnappa[2] in *Solanum giganteum*, *S. melongena* and *S. indicum*. A pair of large chromosomes, recorded as *Type A*, was conspicuous in all the metaphases.



FIGS. 1-3. Fig. 1. Photomicrograph of metaphase chromosomes in root tip of *Solanum elaeagnifolium* Cav. Figs. 2-3. *Solanum elaeagnifolium* Cav. Fig. 2. Camera lucida drawing of the metaphase chromosomes in Fig. 1. Fig. 3. The karyotype.

The karyotype is illustrated in Fig. 3. Terminology as proposed by Battaglia[1] is used to distinguish the different kinds of centromeres and satellites in Table I.

The largest chromosome of the complement, *Type A*, is between four and five microns in length. The smallest chromosome, *Type E*, is slightly less than half as long as the *Type A* chromosome. A point of interest is the presence of two pairs of satellited chromosomes in this diploid species.

TABLE I

Morphology of metaphase chromosomes in root tips of S. elaeagnifolium

Type	Pairs	Description
A	1	Long chromosome with submedian centromere and terminal macrosatellite
B	1	Long chromosome with submedian centromere and terminal microsatellite
C	1	Chromosome of medium length with median centromere
D	8	Chromosomes, medium to short, with submedian centromeres
E	1	Short chromosome with median centromere

The author expresses his thanks to Dr. K. Subramanyam for his interest, to Dr. A. D. Saini for providing the seeds and to Shri C. C. Mukherjee for photography.

Botanical Survey of India, R. P. PATIL.
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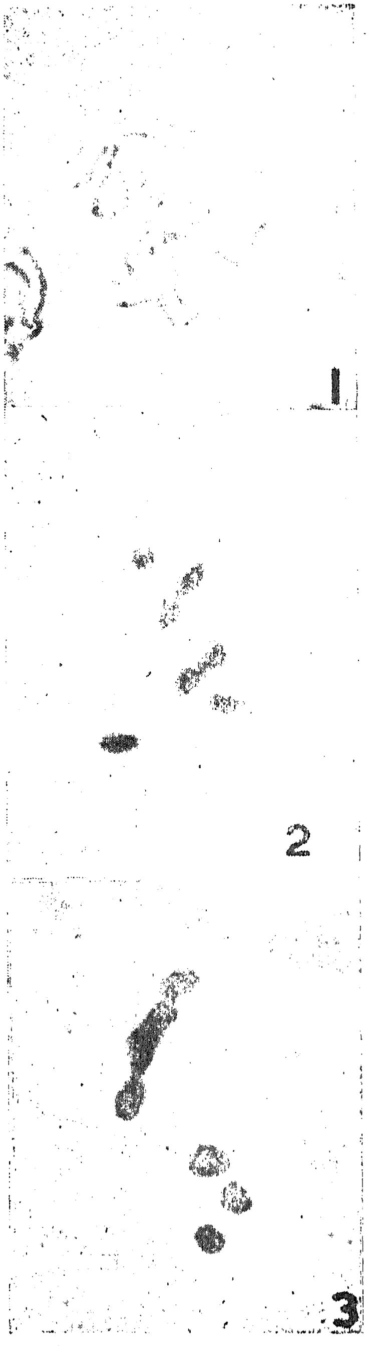
MEIOSIS IN A HAPLOID PEARL MILLET

ONE twin seedling was located among 100 seedlings of *Pennisetum typhoides* Stapf and Hubb., raised for an experimental purpose. One of the seedlings from the twins grew to maturity, produced two spikes and provided the cytological material for the present investigation. This plant was a haploid. The second plant was much weaker and died before flowering. The material for cytological study was fixed in acetic alcohol (1 : 3) and squashed in acetocarmine.

At diakinesis and meta-anaphase I seven chromosomes were observed instead of 14 chromosomes characteristic of the normal diploid *Pennisetum typhoides*. The types of chromosomal associations observed at diakinesis and meta-anaphase I are presented in Table I. The bivalents were of the rod type and looked just like the rod bivalents of the normal diploid plant. The associations of 3 or 4 chromosomes were of the chain type (Fig. 3). A study of the pachytene stages had revealed the occurrence of one, two or three bivalents per cell and the pairing extended along the entire length of the chromosomes and was apparently complete (Fig. 1). The pachytene pairing, however, was



FIGS. 1-3. Fig. 1. Pachytene stage showing 3 bivalents. Fig. 2. meta-anaphase I showing two brivalents oriented on the equatorial plate. Fig. 3. Meta-anaphase I showing association of 4 chromosomes.

not always followed by chiasma formation. In a number of cases the paired chromosomes, observed at diplotene and diakinesis stage, were observed to fall apart and thus at meta-anaphase I a maximum of only two bivalents per cell were realised in a small percentage of cells (Fig. 2), the more frequent condition being one bivalent per cell. The associations of 3 or 4 chromosomes do not seem to be the result of chiasma formation but in all probability represent secondary associations or might be the result of heterochromatic stickiness. In addition to the bivalents, *e-s* and *s-s* associations also were observed. At meta-anaphase I these associations were not observed to co-orient usually on the equatorial plate but were lying away from the equatorial plate or near the poles. The bivalents, on the other hand, in a number of P.M.C.'s, were observed to co-orient on the equatorial region with their daughter halves oriented towards the poles as they are at metaphase and early anaphase in normal cells.

TABLE I

Frequency of different types of association of chromosomes at meta-anaphase I in the haploid

Class	Frequency of cells	Total *s-s* associations	Total *e-s* associations
0_{IIs} ..	76	37	33
$1_{II}+5_{Is}$ ..	65	24	16
$2_{IIs}+3_{Is}$ ..	20	6	3
Association of $3+1_{II}+2_{Is}$	6	..	..
,, $3+4_{Is}$ ..	13	3	2
, $4+3_{Is}$ ..	5	..	..
Total number of cells ..	185	..	..

The *e-s* and *s-s* associations in wheat haploids according to Person,[1] Riley and Chapman[2] and Kimber and Riley[3] are supposed to be the result of the presence of homologous segments in the chromosomes and the realisation of a very low percentage of these associations is likely due to the relatively short nature of these homologous segments. The *e-e* associations in wheat, however, were supposed to be the result of heterochromatic stickiness or an expression of secondary association. Levan[4] on the other hand has clearly shown that non-homologous pairing occurs in haploid rye and according to him "non-homologous pairing plays a dominant role".

At meta-anaphase I the following types of chromosome segregations were observed, 0–7, 1–6, 2–5 and 3–4, the last type being more frequent. In a small number of P.M.C.'s one or two univalents were observed to divide during meta-anaphase I.

The second division was more regular but the wall formation at the end of the second division sometimes failed to take place in one or both the diads. This resulted in the formation of 2, 3 or 4 microspores and microspores with two nuclei. There was much size variation in the pollen grains as a result of irregularity in the wall formation after the second division and also due to the differences in chromosome numbers.

The authors are thankful to Prof. J. Venkateswarlu for the facilities and encouragement. The Junior author expresses her thanks to the U.G.C. for the award of a Junior Research Scholarship.

Department of Botany, J. V. PANTULU.
Andhra University, (MISS) V. MANGA.
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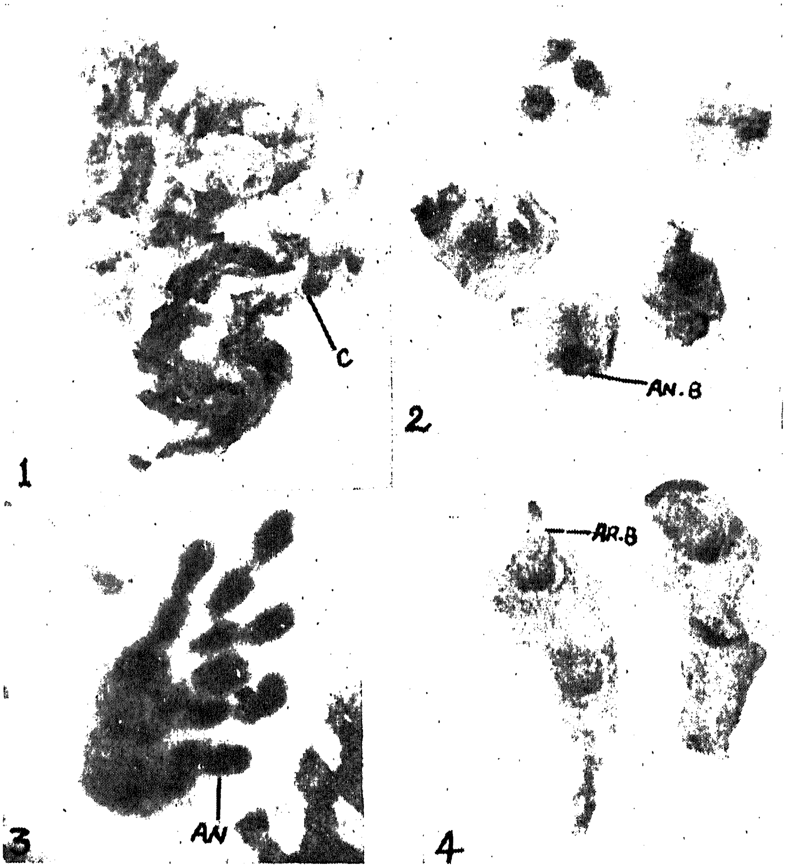
A PRELIMINARY NOTE ON THE SEX-ORGANS OF *LUNULARIA* SPP.

Lunularia is a genus of the family Marchantiaceæ among the liverworts. There are only two species in this genus, *viz.*, *L. cruciata* and *L. lunularis*. The gametophytes of *Lunularia* resemble those of *Marchantia* to a great extent but they can easily be distinguished by the presence of the characteristic crescent-shaped cupules on the dorsal surface (Fig. 1). The thallus is light-green in colour and a little thinner than that of *Marchantia*. Rib-like thickenings are visible from the upper surface. The genus is well known for its very efficient method of asexual reproduction by means of the multicellular gemmæ, owing to which the plant became widely distributed in the western countries after being introduced from Europe with nursery stock. It is a very common liverwort found in the greenhouses in most parts of the United States, but is sufficiently acclimatised to the mild climate of California to grow out of doors (G. M. Smith, 1955). *Lunularia* is found as one of the common liverworts at higher elevations of the hills in South India particularly at Kodaikanal Hills. It does not occur commonly in greenhouses. In this genus the sex-organs which are similar to those of *Marchantia* have not so far been described. The development of the sex-organs appears to be very rare.



FIGS. 1-4. Fig. 1. Plants of *Lunularia* showing the general habit. The crescentic gemma cups are clearly visible. Fig. 2. Male plants showing the antheridial receptacles. Fig. 3. Close up of antheridial receptacle showing the antheridia as dark oval bodies. Fig. 4. Female plants of *Lunularia*, with the base of the archegoniophore. C = Cupule; A.N.B. = Antheridial branch; AN = Antheridia; A.R.B. = Archegonial Branch.

The material under investigation was collected during several visits to the Kodaikanal Hills on annual botanical excursions and was grown in the laboratory, with the object of studying the sexual reproduction in the genus about which no previous information is available. The attempts have met with success only after a long period of eight years.

The male thalli are smaller in size and not much elongated. The antheridial receptacles are borne at the apex of the thallus which can easily be recognized by the dark regions (Fig. 2). The sessile antheridial receptacle bears many antheridia in the antheridial chambers on the dorsal surface. As many as 26-28 antheridia could be observed from the dorsal surface, appearing like dark bodies (Fig. 3). Each antheridium surrounded by its own antheridial chamber is a distinctly stalked structure. The antheridial chamber opens to the outside through an ostiole on the upper surface.

The female thalli are much bigger in size than the male plants, being much longer. These bear the archegoniophores (Fig. 4). A few sporophytes have also been observed in the course of this investigation.

I wish to express my sincere thanks to Professor M. Nagaraj, Central College, and Professor T. Thathachar, National College, Bangalore, for their kind encouragement.

Dept. of Botany, T. R. BALACHANDRA NAIDU.
Central College,
Bangalore, *September* 12, 1968.

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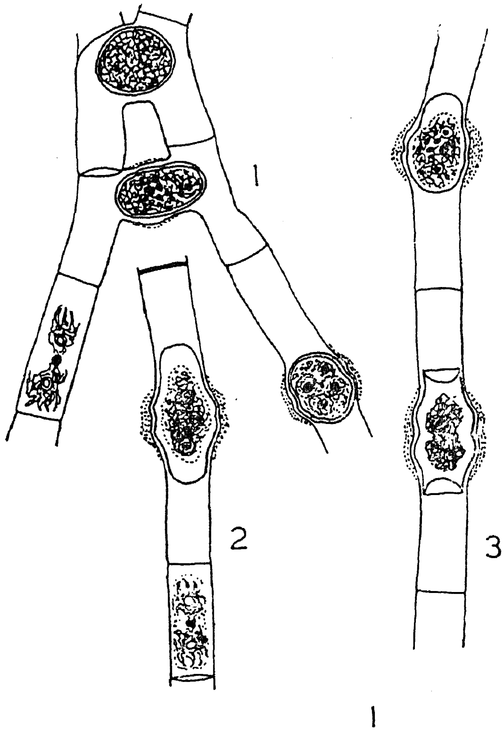
ZYGNEMA HIMALAYENSE RANDHAWA FROM GUJARAT

Zygnema himalayense Randhawa was established by Randhawa in 1940.[1] It was collected from freshwater stream, Loharkhet, 7750 ft. above sea-level, Almora, in September 1939. It is now reported from Gujarat.[3]

The present alga was collected as free floating from a pond at Bhavanagar in September 16, 1967. Bhavanagar is situated at nearly sea-level, on 72–15 E. long. and 21–75 N. lat. on the Bhavanagar creek of the gulf of Cambay.

Vegetative filaments are 20·7–23·5 μ broad and 1½–5 times as long as broad. The cell contains two stellate chloroplasts, each with a conspicuous pyrenoid in the centre. Nucleus is situated in between the two chloroplasts. In some cases, cells with four chloroplasts have also been observed. Reproduction of both types—scalariform and lateral—is observed. Lateral conjugation is predominant. In some cases, the neighbouring cells of the same filaments showed both scalariform and lateral conjugation. Lateral conjugation is isogamous type. Here, the aplanogametes move towards the transverse septum between two gametangia and the wall between the two dissolves away, allowing the fusion of the gametes at the centre. At the same time, the swelling and the formation of the grooves in lateral walls between two gametangia take place. The wall of the developing zygospores also develops the groove. Finally, the grooves disappear and the zygospores become generally globose. The knee-shaped bending of the filaments at the time of lateral conjugation is a noteworthy point. Mature zygospores are globose to sub-globose and bluish-green in colour. They measure from 23·0 to 30·0 μ across. The spore wall is scrobiculate.

The species, described here, generally agrees with *Zygnema himalayense* Randhawa. The dimensions of the vegetative filaments as well as of zygospores are similar in the present species, but the mode of scalariform and lateral conjugation is exactly similar to that of *Z. himalayense* Randhawa.[1] Randhawa has figured the grooves on the lateral walls of the gametangia.[1,2] In the present species these grooves are formed by both the lateral wall as well as the wall of the developing zygospores.



FIGS. 1–3. *Zygnema himalayense* Randhawa. Fig. 1. Showing scalariform and lateral conjugation. Figs. 2–3. Showing the development of grooves both in the lateral walls as well as in the walls of the developing zygospores (Figs. 1–3, × 320).

Thanks are due to Mr. Kothari and Mr. Bhatt for the collection made for the authors.

Dept. of Botany, R. J. PATEL.
Sardar Patel University, C. K. ASHOK KUMAR.
Vallabh Vidyanagar, District Kaira,
Gujarat State (India),
October 10, 1968.

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SCHISTOSOMAL CIRRHOSIS IN PIGS IN JABALPUR, M.P.

SCHISTOSOMIASIS is a common infection in equines, sheep, goat, cattle and buffaloes in this country. According to Sinha and Shrivastav[4] and Ahluwalia,[1] schistosomiasis is also common in pigs in Uttar Pradesh. However, Rao and Ayyer[3] and Alwar[2] found it in only 5 and 8% respectively in the pigs examined in Madras. Very little is known about its infection in other parts of India including Madhya Pradesh. We report its infection in local pigs.

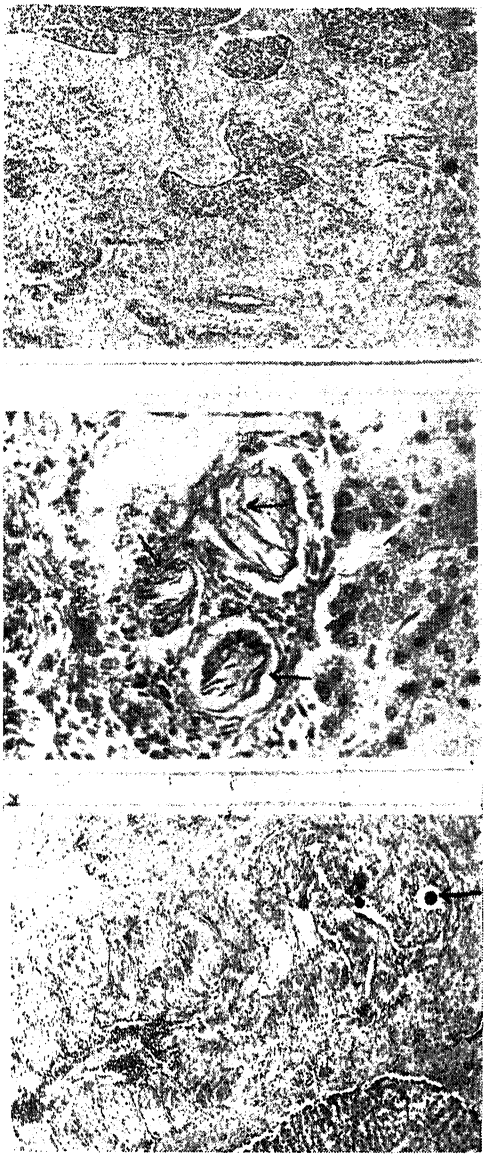
During the period October 1967 to March 1968, livers of 37 indigenous pigs slaughtered locally were examined post-mortem. Those suspected to be cirrhosed were further examined for evidence of schistosomiasis. Affected livers were teased in saline to get the worms which were studied by permanent mounts. Pieces of cirrhosed livers were fixed in 10% formal-saline for histological study. Sections were examined after staining with H and E.

Eighteen of 37 livers examined were cirrhosed. Adult *Schistosoma incognitum* recovered from one liver conformed to the description given by Sinha and Srivastav.[4]

Macroscopic lesions.—Lobulations were very prominent and the livers were difficult to cut through.

Microscopic lesions.—The microscopic picture was of periportal cirrhosis. Interlobular tissue was heavily infiltrated with inflammatory cells (endotheloides, eosinophils and lymphocytes) and this, together with fibrosis, had resulted in a considerable reduction of the liver lobules (Fig. 1). Schistosome eggs, with or without inflammatory cells, were found at the periphery of the lobules in all the cirrhosed livers. In heavily infected livers it was difficult to find any healthy hepatic tissue. Usually one egg was found in one microscopic field and on some occasion three were found together. All known stages of formation of bilharzial pseudotubercles were seen by us. Bile ducts were hyperplastic and some of them showed degenerative changes. In a heavily infected liver, the arteries showed a narrowing of the lumen due to endothelial proliferation and some of the larger arteries showed fragmentation and degeneration of muscular linings (Fig. 3).

Perhaps due to the low egg production of *S. incognitum*, no characteristic lesions are found in its infection; one usually finds a single egg in *S. incognitum* whereas many can be found in *S. indicum*. In the present study, eggs were detected histologically but only after prolonged search. It may explain why this condition has not attracted the attention of pathologists in this State.



FIGS. 1-3. Fig. 1. Microphotograph showing interlobular thickening. Note the reduction of liver lobules, × 40. Fig. 2. Microphotograph showing a group of three schistosome eggs, × 265. Fig. 3. Microphotograph showing an artery cut longitudinally. Note the degeneration of muscular lining and a schistosome egg in the right upper corner, × 45.

Occurrence of three eggs in one microscope field (Fig. 2) seems unusual as a single egg is found usually in a lesion (Ahluwalia).[1] In a heavily infected liver, vascular lesions were found. To our knowledge these have not been reported before in animal schistosomiasis.

We thank Dr. R. L. Kaushal for the facilities provided.

Dept. of Parasitology, College of Veterinary Science, Jabalpur, *October* 23, 1968.
H. O. P. SHRIVASTAV.
J. P. DUBEY.*

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* Present address: Department of Pathology, Medical Centre, University of Kansas. U.S.A.

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LOCAL LESION HOST FOR GRASSY SHOOT VIRUS OF SUGARCANE*

GRASSY shoot disease, a virus disease of sugarcane is characterised by stunted growth, profuse tillering, suppression of cane formation and chlorosis, and is more severe in the ratoons. It is transmitted through diseased setts, juice from diseased stalks, sap from diseased leaves, cane cutting knife and the *aphid* vectors (*Longiunguis sacchari*, *Aphis idiosacchari* and *Aphis maidis*).[1,2] The virus is inactivated in diseased setts by hot water at 50° C. for 2-3 hours.[3]

The virus is transmissible but the symptoms take a long time, up to 8–10 months, to appear. If the shoots are ratooned after 3–4 months, the new shoots may show the leaf symptoms in another 2–3 months with distinct symptoms of the disease appearing after 5–6 months. In order to find an indicator plant for detecting the presence of the virus, following plants were tested: *Chenopodium amaranticolor* Coste and Reyn., *C. ambropoides*, *Datura stramonium* L., *Gomphrena globosa* L., *Nicotiana glutinosa* L., *N. tabacum* L. (White Burley), *N. tabacum* var. *xanthi*, *Petunia hybrida* Vilm. *Sorghum vulgare* L., *Vigna sinensis* Savi, and *Zea mays* L.

The plants were raised in pots containing sterilized mixture of garden soil and compost inside a glasshouse and inoculated by rubbing the leaves with inoculum which was prepared by freezing leaves from affected plants (var. Co. 419) overnight and grinding them in 0·5% Na_2SO_3 solution (one ml. per gram of leaf material). Carborundum (400 mesh) was used in the inoculations. Control plants were inoculated with sterile distilled water.

Leaves of inoculated plants of maize and *Sorghum* showed chlorosis with stripes similar to grassy shoot symptoms of sugarcane leaves within 15–20 days. There was also stunting and increased tillering in the case of *Sorghum*. Leaves of *Petunia* plants showed chlorosis. The virus was transferred back to its host (var. Co. 419) when the sap was placed in the spindle of two months old healthy sugarcane plants and pricked with a fine needle, producing pale to yellow stripes on leaves within 6–7 days.

Local lesions appeared on leaves of *C. amaranticolor* and *N. glutinosa* when inoculated with sap from leaves of Co. 419, showing yellow stripes characteristic of the disease, 4–5 days after inoculation as well with sap from chlorotic leaves of *Petunia* and maize. Such lesions were not produced when sap was directly taken from leaves of grassy shoot diseased sugarcane plants. On *C. amaranticolor* averages of 76·3 lesions were produced with sap from leaves of Co. 419, 83·5 from yellow striped leaves of maize, 146·0 from chlorotic leaves of *Petunia* and 178·5 from local lesion leaves of *N. glutinosa*, indicating possible variations in titre of the virus in different hosts.

Sap from sugarcane (var. Co. 419) leaves within 15–20 days after appearance of symptoms alone gave local lesions.

Thanks are due to Dr. K. V. Srinivasan, Plant Pathologist, for going through the manuscript and suggestions.

Sugarcane Breeding Institute,
Coimbatore-7,
October 10, 1968.
G. R. SINGH.

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* Approved for presentation by the Director, Sugarcane Breeding Institute, Coimbatore.

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PEYSSONELIA ANTIQUA JOHNSON FROM THE BAGH BEDS OF MADHYA PRADESH

IN the present communication the authors record the presence of *Peyssonelia antiqua* Johnson, a squamariacean alga new to the Indian region, in the Bagh Beds of the Narbada Valley in M.P. The Narbada basin developed during Jurassic-Cretaceous times on the eroded early Mesozoic surface of the Indian shield and the Bagh Beds represent the marine deposits of the Cretaceous transgressive cycle laid down in these basins.

SYSTEMATIC DESCRIPTION

Phylum RHODOPHYCOPHYTA
Family SQUAMARIACEAE
Genus *Peyssonelia* Decaisne 1841
Peyssonelia antiqua Johnson 1964
Fig. 1 (× 40)

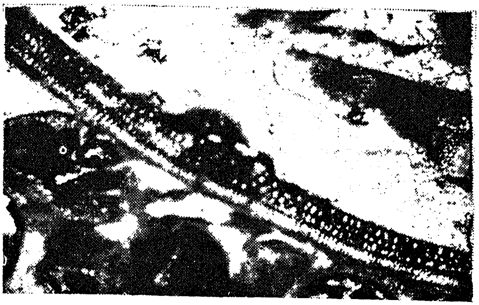

FIG. 1

Peyssonelia antiqua Johnson, 1964, Vol. 10, No. 2, p. 214, pl. 1, Fig. 2.

Peyssonelia antiqua Johnson, 1965, No. 1, pp. 67-68, pl. 27, Figs. 1-4.

Description.—Small thin crusts consisting of a basal hypothallus, perithallus, and dermal layer. The hypothallus consists of a single layer of large irregular, more or less rectangular cells which commonly measure 24–40 μ high and 15–23 μ wide. The perithallus is formed of short vertical threads of rounded to rectangular cells, commonly 3 to 5 cells thick. Normally the threads have the largest cells at the base and the smallest at the top. The threads may bifurcate. Cells measure 15–36 μ high and 9–28 μ wide. An upper dermal layer consists of one or two layers of flat cells. These cells have a thickness ranging 7–13 μ, commonly 8·5 μ.

Remarks.—The present specimens strikingly resemble the type material described by Johnson (1964) from Iraq and those from Guatemala. The diagnostic features of the species are better represented in the present materials.

Horizon and Locality.—Upper Coralline Limestone; Palæocene(?); Chirakhan, Sitapuri.

Figured slide C.L./41.

The present find of *Peyssonelia antiqua* in the Bagh Beds is quite significant in view of the stratigraphy and age of these strata. Till recently fossil invertebrates served as the only means of ascertaining the age of these strata. Duncan (1865), Bose (1884), Vredenburg (1907), Chiplonker (1937–41) and others considered the fauna to be Cenomanian-Senonian in age while Fourtau (1918) considered the Bagh Echinoids to belong to the Albian. Recent palæobotanical studies by the authors have yielded interesting results. Ghosh and Pal (1968) found in these strata *Cayeuxia fructilosa* Johnson, a codiacean alga belonging to the Uppermost Cretaceous to Mæstrichtian age. Pal (1968) found species of *Distichoplax* pia which enjoy universal acceptance as an ideal index fossil for the Palæocene.

Peyssonelia antiqua is essentially a Palæocene-Eocene form. It was originally described by Johnson (1964) from the Palæocene limestone of Rowanduz in northern Iraq which unconformably overlie the late Cretaceous (Mæstrichtian) strata. In Guatemala the species occurs in the Petén Formation which consists of light-coloured limestones, dolomites and evaporites, in association with Palæocene for aminiferal species, *e.g.*, *Truncorotalia*, *Globorotalia*, *Globigerina*, etc. (Johnson, 1965).

It may be mentioned in this connection that Palæocene-Eocene strata occur "in continuation of, and overlying the Cretaceous rocks in the Pondicherry area" (Rama Rao, 1953, p. 76). It may not be out of place to suggest that the sedimentation in the Narbada basin also continued beyond the Cretaceous and possibly through the Palæocene.

Thanks are due to Dr. J. Harlan Johnson, Emeritus Professor of Geology, Colorado School of Mines, who took much interest in the present work and made valuable suggestions.

Palæobotany Laboratory, A. K. GHOSH.
Department of Botany, A. K. PAL.
Calcutta University,
Calcutta-19, *November* 7, 1968.

---

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REVIEWS AND NOTICES OF BOOKS

Film-Forming Compositions (Vol. 1), Part II. Edited by Raymond R. Myers and J. S. Long. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xi + 434. Price $ 28.75.

For more than twenty years there has not appeared in the United States a treatise of more than two volumes concerning the raw materials and finished products of coatings industry. In this age of rapid change and development this treatise is timely. Carrying forward the work begun by Mattiello, this multivolume treatise is designed to furnish a comprehensive coverage of the numberless facets of the coatings industry today. The two editors hold the titles of former and present Director of the Paint Research Institute.

The articles contained in this volume are: Styrene-Butadiene Latexes in Protective and Decorative Coatings; Starch Polymers and Their Use in Paper Coating; Cellulose Esters and Ethers; Drying Oils—Modifications and Use; Paint and Painting in Art; Rosin and Modified Rosins and Resins; Urea and Melamine Resins; Vinyl Resins; and Vinyl Emulsions.

This book will be of service to chemists, formulators, laboratory assistants, technicians, and production superintendents of the coatings industry. It is also valuable for laboratory personnel of the raw materials suppliers, chemists in the plastics and similar industries, and is a reference treatise for libraries.

C. V. R.

Annual Review of Phytopathology (Vol. 6). Edited by J. G. Horsfall. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. vii + 456. Price: Postpaid U.S.A. $ 8.50; Foreign $ 9.00.

Volume 6 of the *Annual Review of Phytopathology* was planned by the Editorial Committee at the 1966 Meetings of the American Phytopathological Society with the able assistance of W. A. Kreutzer and R. R. Baker as guests.

Beginning with this volume, reviews of interest to plant pathologists in other journals published by Annual Reviews, Inc., will be listed each year.

The articles contained in this volume are: APPRAISAL OF DISEASE: 1. Aerial Photography for the Study of Plant Diseases; 2. Status of American Stem Rusts of Pine. PATHOGENS: 1. Trends in the Development of the Plant Virology; 2. DNA Base Composition and Hybridization in the Taxonomy of Phytopathogenic Bacteria; 3. The Dynamics of Nematode Movement; 4. The Growth Process in Fungi; 5. Variation in the Smut Fungi; 6. Current Status of *In vitro* Synthesis of Plant Viruses. PHYSIOLOGY OF HOST-PATHOGEN INTERACTION: 1. Insect Secretions in Plants; 2. Inoculum Production and Infection by Foliage Pathogens; 3. Permeability Phenomena in Plant Disease; 4. Factors Influencing Expression of Oxidant Damage to Plants. GENETICS OF HOST-PATHOGEN INTERACTIONS: Genetics of Pathogenicity of *Phytophthora Infestans*: EPIDEMIOLOGY-DISEASE IN POPULATION: 1. Role of Aphids in the Ecology of Plant Viruses; 2. Interpreting Plant Disease Dispersal Gradients. CHEMICAL CONTROL: Chemical Control of the Cereal Rusts; BIOLOGICAL AND CULTURAL CONTROL: Mechanisms of Biological Control of Soil-Borne Pathogens. SPECIAL TOPICS: Vesicular-Arbuscular Mycorrhiza and Plant Growth and other reviews of interest to Plant Pathologists.

C. V. R.

The Measurement of Environmental Factors in Terrestrial Ecology (*British Ecological Society Symposium Number Eight*). Edited by R. M. Wadsworth. (Blackwell Scientific Publications, Oxford and Edinburgh), 1968. Pp. ix + 314. Price 55 *sh.*

The object of this volume has been to bring together details of methods which the ecologist can expect to be able to use in the field and to discuss the recording and handling of the records obtained. Many specialist books and symposia dealing with the measurement of the environment have been published in the last few years but the ecologist, because he is not a specialist in the techniques of making these measurements, has often found it difficult to obtain the information on techniques which he needs. That this difficulty is widespread amongst ecologists was confirmed by the large attendance at the symposium. This volume will help to increase the understanding of the environment of plants and animals by making information on methods more readily available to the ecologist.

This volume contains twenty articles. Some of the interesting articles are: Instruments and Techniques for Measuring the Microclimate of Crops, by I. F. Long; The Measurement of Apparent Surface Temperature, by D. B. Idle; The Measurement of Wind Speed and Direction in Ecological Studies, by J. M. Caborn; Interception of Rainfall by Trees and Moorland Vegetation, by L. Leyton, E. R. C. Reyholds and F. B. Thompson; Measurement of Radiant Energy, by G. Szeicz; Techniques used in the Study of the Influence of Environment on Primary Pasture Production in Hill and Lowland Habitats, by M. B. Alcock, J. V. Lovett and D. Machin; and Crop Environment Data-acquisition, by M. J. Blackwell and M. R. Blackburn.

Further a short account of the demonstrations on Temperature, Radiation, Wind Speed and Direction, Humidity, Rainfall and Evaporation, Soil Water, Analysis of Gas in the Atmosphere and in the Soil Atmosphere, Recording and Miscellaneous are given in the book.

C. V. R.

Spectra of Nucleic Acid Compounds. By Tat'yana V. Venkstern and Aleksander A. Baev. (Translated from Russian. Plenum Publishing Corporation, 227, West 17th Street, New York), 1968. Pp. 79. Price $ 15.

This is a translation of the second Russian edition on the title, but it has been modified and also supplemented. The main contents are 65 full page charts exhibiting ultraviolet absorption bands (mostly in the region 220–320 $m\mu$) of bases, nucleosides, nucleotides and oligonucleotides entering into the composition of ribonucleic acids. There is an introductory chapter of seven pages.

For most of the compounds spectra are given in 0·1 N HCl, in 0·1 N KOH, and after bromination. Each chart also gives the name of the compound, molecular formula, molecular weight, structural formula, positions of maxima and minima, and extinction coefficients. This atlas of minor components of RNA will no doubt be a useful ready reference work for biochemists and researchers in nucleic acid.

A. S. G.

ANNOUNCEMENTS

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Technology to Shri S. S. Subrahmanyam.

The M.S. University of Baroda has awarded the Ph.D. degree in Biochemistry to Shri K. Ramachandran.

The Utkal University has awarded the Ph.D. degree in Physics to Shri B. C. Panda.

Summer School in Physics of Condensed Matter

Under the auspices of the Tata Institute of Fundamental Research, Bombay, a Summer School in Physics of Condensed Matter will be held at the Indian Institute of Science, Bangalore, from June 9 to June 27, 1969. Lectures will be given by Prof. K. S. Singwi of Argonne National Laboratory, USA, on "The Theory of Atomic Motions in Liquids" and by Prof. A. T. Stewart of Queen's University, Canada, on "Positron Annihilation in Solids and Liquids".

Further information may be obtained from Shri V. G. Kulkarni, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay-5.

Books Received

Organic Semiconducting Polymers. By J. E. Katon. (Marcel Dekker, Inc., New York 10016), 1968. Pp. x + 315. Price $ 18.75.

Medical Research Series (Vol. 3)—*Selected Pharmacological Testing Methods.* Edited by A. Burger. (Marcel Dekker, Inc., New York 10016), 1968. Pp. xiv + 515. Price $ 23.75.

Treatise on Coatings (Vol. I)—*Film-Forming Compositions (II).* Edited by R. R. Myers and J. S. Long. (Marcel Dekker, Inc., New York 10016), 1968. Pp. x + 315. Price $ 18.75.

Organic Chemistry—An Introductory Text (3rd Edition). By C. W. Wood, A. K. Holliday and R. J. S. Beer. (Butterworth and Co., London, W.C. 2), 1968. Pp. xxvii + 346. Price 25 *sh.*

NBS Monograph 70 (Vol. IV)—*Microwave Spectral Tables Polyatomic Molecules Without Internal Rotation.* (National Bureau of Standards, Washington D.C. 20234), 1968. Pp. xii + 418. Price $ 5.50.

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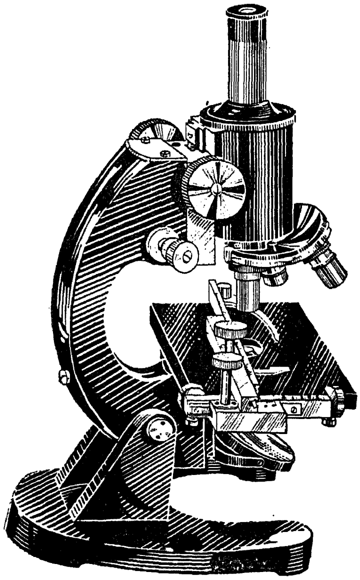

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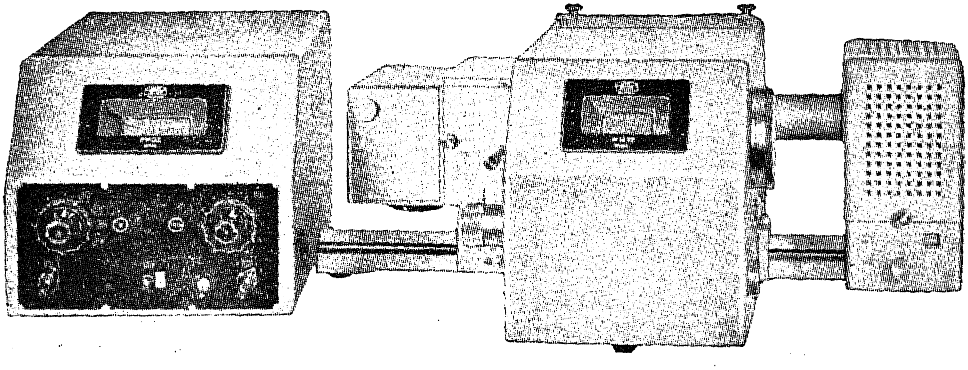

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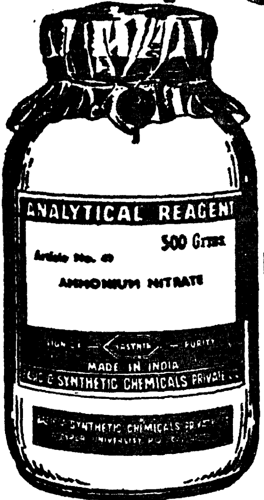

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DETERMINATION OF THE FREE RADICAL CONTENT OF RICE DURING FLOWERING BY THE ESR TECHNIQUE

J. J. CHINOY, O. P. SAXENA, I. C. DAVE, K. GURUMURTI, R. B. PANDYA AND P. G. ABRAHAM

Botany Department, University School of Sciences, Gujarat University, Ahmedabad-9, India

CONSIDERABLE evidence has accumulated by now to highlight the importance of free radicals in the process of energy transfer not only in pure chemical reactions but also in biological processes of both the plant and the animal.[1] Commoner and his associates[2] have done pioneering work in experimentally establishing the participation of free radicals in one-electron transfer by study of electron spin resonance in biological materials. Commoner[3] has also confirmed the photosynthetic free radical component (II) in isolated chloroplasts as well as in whole living algæ. Gurevich[4] reported that isolated wheat and corn embryos, etiolated corn seedlings and the embryonic parts of corn leaves all contained a special enzyme, peroxidase, which catalyzed the production of the free radical of ascorbic acid, called monodehydroascorbic acid.

Enhancement in metabolic processes as well as an increase in the productivity of cucumber and tomato plants raised from irradiated seeds was found to be due to the increased concentration of free radicals.[5]

It has been shown in this laboratory that higher ascorbic acid (AA) content as well as its utilization (AAU) synchronize with a change in the shoot apex of cereals from the vegetative to the reproductive state.[6] The activity of the special peroxidase, which produced the free radical of AA, was also found to be at a higher level during the period of reproductive differentiation[7] compared to that prevailing during the vegetative phase indicating enhanced production of AA-free radical.

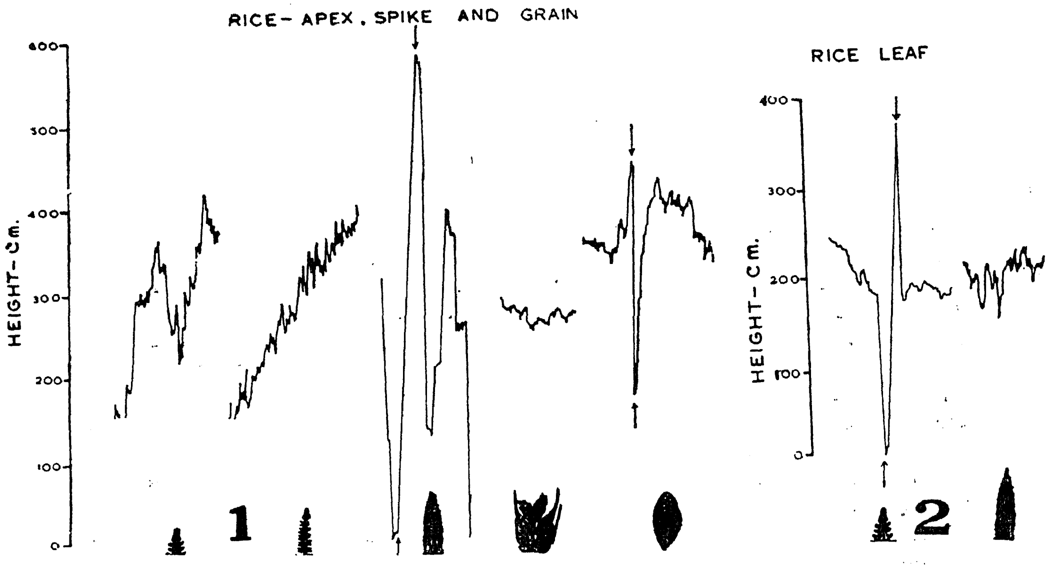
It was therefore considered of interest to confirm the presence of free radicals which were previously determined biochemically by the ESR technique during the periods of vegetative and reproductive differentiation of some plants. The data for free radicals are presented here only for rice in terms of arbitrary units—height of the signal in cm./g. fr. wt. for the sake of simplicity of comparison for various growth and developmental stages. The detailed quantitative work on this aspect will be reported elsewhere.

Vegetative shoot apex, primordial spike, floral organs and developing grain as well as leaves at the above-mentioned stages of rice var. HR-5 were collected from growing crop. The tissue was weighed immediately and transferred to the moist filter-paper in blackened petri dish so as to check the initiation of senescence and light-induced ESR signals. The intact tissues were dissected just before their transfer to the sample tube in order to prevent increase in peroxidase activity in excised tissues. The samples were screened for free radicals using a modified version of a Varian 100 Kc electron spin resonance spectrometer. The samples were weighed and pressed gently between the two filter-papers and then the samples were transferred to the sample tube to be fixed in a sample cavity in a Dewar flask containing liquid nitrogen at 77° K. (− 196° C). The data (height of the signal in cm.) presented in Figs. 1 and 2 have been calculated for a gram fresh weight of tissue and to constant values of the 100 Kc field modulation and amplifier gain.

The free radical content in the shoot apex slowly increases during the period of vegetative differentiation. However, at the time of transformation of the shoot apex from vegetative to reproductive phase, a many-fold increase in the production of free radicals is clearly seen. The free radical content decreases in the primordial spike. A sharp rise in the free radical content is recorded once again during the embryo differentiation of developing grains (Fig. 1).

The free radical content of the leaf is higher during the period of vegetative differentiation compared to that found in the same organ during the period of reproductive differentiation (Fig. 2).

The g-value of the observed electron spin resonance is close to the free electron value of 2·0023 and one can be reasonably certain that the free radicals are organic in nature. On the basis of the fact that AA, AAU and the FR-peroxidase increased considerably during the period of reproductive differentiation one of us[8] has postulated that the enhanced



FIGS. 1-2. Fig. 1. Free radical content in shoot apex, spike and developing kernels of rice. Fig. 2. Free radical content in leaf of rice.

concentration of free radical of AA (and perhaps that of other organic substances) during the period of reproductive differentiation supplied enhanced electronic energy for the highly activated biosynthesis of DNA, RNA, proteins, enzymes and other cell constituents required for accelerated cell division and laying down of growth centres during the process of flowering. The present work confirms by EPR measurements the presence of increased free radical content of rice during the flowering process.

Financial assistance by P.L. 480, Research Grant No. FG-IN-182 (A7-CR-87) entitled 'Physiology of seed germination in relation to early production of ascorbic acid and ascorbic acid oxidase in wheat (*Triticum*) and peanut (*Arachis*)' is gratefully acknowledged. We are thankful to Prof. B. Venkatraman and Mr. M. V. Krishnamurthy of the Tata Institute of Fundamental Research, Bombay-5, for all help in obtaining the ESR spectrum of the samples as well as for helpful suggestions and discussions for calculating the data.

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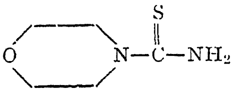
ON THE SUPPOSED "4-MORPHOLINYL-(THIOCARBONIC) ACID AMIDE"

D. VENKAPPAYYA AND G. ARAVAMUDAN
Department of Chemistry, Indian Institute of Technology, Madras-36

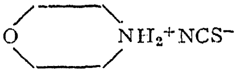
IN connection with our investigations of co-ordinating characteristics of morpholine and its derivatives, preparation of substituted thiourea compound of morpholine was attempted. It is well known that when secondary amines (RR'NH) are reacted with isocyanates and isothiocyanates in basic medium substituted ureas (RR'NCONH$_2$) and thioureas (RR'NCSNH$_2$) are formed respectively.[1] Morpholine is a typical secondary amine and so it is also expected to give similar type of compound, namely, 4-morpholinyl-(thiocarbonic) acid amide (MTCA) when it is treated with, say, potassium thiocyanate under alkaline conditions. Henry and Dehn[2] indeed reported the isolation of this compound,



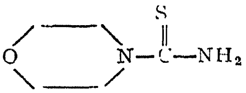
(m.p. 112·5–115·5° C.), under slightly different conditions by dissolution of morpholine hydrochloride and potassium thiocyanate in 1 : 1 mole ratio in water and evaporating the solution to dryness. The dry solid was extracted with anhydrous ethanol to separate the insoluble potassium chloride formed and the solution was concentrated to get the crystals of MTCA. We attempted the preparation of above compound exactly under similar conditions. The melting point of the compound prepared by us agreed with that of the reported value. The microanalytical estimation of carbon and hydrogen in the compound supported the formula C$_5$H$_{10}$ON$_2$S.

However, aqueous solution of this compound, even after its repeated recrystallisations gave an intense red colour with acidified ferric solution, a reaction which is characteristic of thiocyanate group and not of a thiocarbamide. The presence of morpholinium ion and thiocyanate ion in the aqueous solution of the compound was confirmed by ion exchange experiments. Passing 20·00 ml. of 0·1 M solution of the compound through a column of Dowex 50 W–X 8 cation exchanger (in the H$^+$ form) released 2 m. equivalents of hydrogen ions. In the same way passing 20·00 ml. of 0·1 M solution of the compound through a Dowex 2–X 4 anion exchanger (in the OH$^-$ form) released 2 m. equivalents of OH$^-$ ions. In the latter case thiocyanate ion was detected in the anion column by ferric test. In addition to simple chemical tests and ion exchange experiments the molar conductances of this compound were measured for 10^{-3} M solutions in water, anhydrous methanol and acetone at room temperature and they were found to be 139·3, 113·1 and 80·19 ohm^{-1} cm.^{2} respectively. These values show the ionic nature of the compound in solution phase.

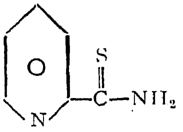
So, it appeared that the compound isolated by Henry and Dehn's method might have been only morpholinium thiocyanate. Or it could be that the compound existed as MTCA in the solid state but dissociated in polar solvents to give morpholinium and thiocyanate ions. This type of dissociation for various substituted thioureas has been studied by Shaw and Walker.[3] However, the rate of transformation reported by them for various thioureas is extremely small. To ascertain the state of the compound in the solid state infrared spectrum of this was taken using KBr pellet technique in a Perkin Elmer 337 instrument. The spectrum of the compound contained strong absorption bands around 2050 and 750 cm.$^{-1}$. These are characteristic of C–N and C–S stretching modes in ionic thiocyanates.[4] This strongly favours the formulation of the compound as



and not as



even in the solid state. It is to be pointed out that 2-amidothiopyridine



a thiocarbamide[5] with carbon attached to the ring system, as would have been also in MTCA, does not exhibit any absorption bands around 2050 and 750 cm.$^{-1}$. This is a strong argument in favour of the ionic structure for the compound.

An alternate procedure for the preparation of the supposed MTCA was attempted starting from a mixture of morpholine and ammonium thiocyanate containing morpholine in slight excess than corresponding to 1 : 1 molar ratio. Ammonia, being more volatile than morpholine, was displaced by morpholine from ammonium thiocyanate by heating the mixture on the water-bath. The crystals obtained on cooling the concentrated solution were washed with acetone and recrystallised from anhydrous ethanol. The melting point, chemical behaviour and infrared spectrum of this compound were identical with those got for the compound which was prepared by adopting Henry and Dehn's procedure. Thus we conclude that both methods of preparation yield only morpholinium thiocyanate and not MTCA.

Keeping the morpholinium thiocyanate at the melting point for long periods and cooling it also did not bring about any conversion to thiocarbamide. Such conversions sometimes do occur as in the well-known case of ammonium thiocyanate to thiourea. It is strange that morpholine alone, among many of the secondary amines should behave in this manner to give morpholinium thiocyanate and not thiocarbamide.

---

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CHROMOSOMAL ANALYSIS OF YOSHIDA ASCITES SARCOMA IN RATS

MISS PRASANNA S. BELUR AND M. SIRSI
Microbiology and Pharmacology Laboratory, Indian Institute of Science, Bangalore-12

INTRODUCTION

CHROMOSOMAL patterns of cancer cells have been studied extensively to elucidate correlation if any, between abnormalities of structure and number of chromosomes with the biological characteristics of the tumour.[1]

While the chromosome constitution of some tumours remain fairly stable during serial animal passages and different transfer generations, very often the derived sublines from the parent strain show considerable variation. This type of variations become more frequent with environmental changes like the strain of the animals used for maintenance of the tumours, the source material transplanted, whether ascites cells or cells obtained from solid forms of the same type of tumour, etc.

The present investigation was undertaken to study the chromosomal pattern of the Yoshida ascites sarcoma maintained in our laboratory and their stability or variability in different transfer generations during animal passage over the last few years.

MATERIALS AND METHODS

Yoshida ascites sarcoma (YAS) obtained from the Indian Cancer Research Centre, Bombay, who in turn had received the tumour from Professor Druckeray of Germany is being maintained in our laboratory since four years in inbred strain of wistar rats A/I.I.Sc. Intraperitoneal transplantation of 25 to 30 million cells every 5th day is the maintenance routine. The ascites developed with this dose becomes hæmorrhagic by 5th day and the average survival period of the animal is seven days.

At one stage, after about 80 transplant generations, the ascites form had to be regenerated from the solid tumour by homogenising the tumour mass and injecting the suspension intraperitoneally. Since then the ascites form is transplanted serially for over 208 generations.

Specimens for chromosomal analysis were prepared as follows: Colchicine in physiological saline (0·035 mg./kg.) was injected intraperitoneally into ascites tumour of five days growth; ascites tumour was aspirated $3\frac{1}{2}$ hr. after the injection, mixed with fifteen times its volume of 0·04 M sodium chloride solution, shaken well and incubated at 37° C. for 10 minutes.[2] The material was centrifuged, supernatant discarded and the sedimented tumour cells were fixed with Carnoy's fixative (ethanol, acetic acid, 3 : 1). The cells were then processed for spreading on glass slides as per the method of Moorhead *et al.*,[3] stained with Giemsa and mounted in canada balsam. A large number of colchicine arrested metaphase plates were observed.

One hundred well spread metaphase plates were examined for each specimen. All metaphase chromosomes were examined by microphotography and camera lucida drawings.

The chromosome numbers of 44th, 66th and 111th generations of tumour cells were determined and a morphological study and karyotyping was carried out.

RESULTS AND DISCUSSION

The chromosome number of Yoshida ascites sarcoma at different transfer generations is shown in Table I and Fig. 1. Karyotype at 111th generation is shown in Fig. 2. Chromosomes are classified morphologically according to the location of the centromere into metacentrics, sub-metacentrics and telocentrics. A change in the modal number has been observed at different transfer generations such as 37 at 44th, 35 at 66th and 40 at 111th generations,

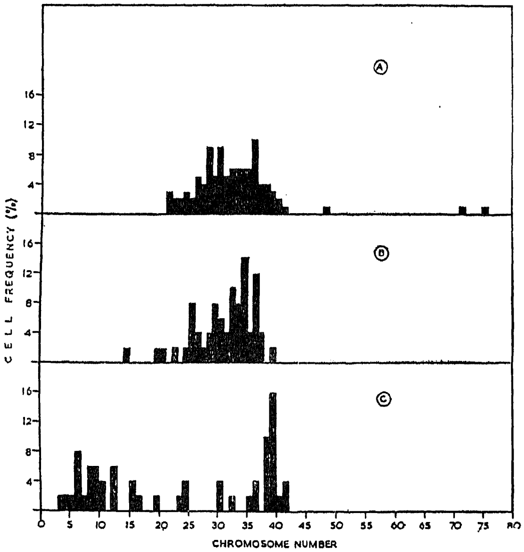

FIG 1. Histogram showing the distribution of chromosomes in Yoshida ascites sarcoma. A, B and C represent the chromosome numbers of 44th, 66th and 111th generations respectively.

TABLE I

Distribution of chromosomes in Yoshida ascites sarcoma at different transfer generations

Chromosome Numbers	Generation number		
	44	66	111
4	..	..	2
5	..	..	2
6	..	..	2
7	..	..	8
8	..	..	2
9	..	..	6
10	..	..	6
11	..	..	4
13	..	..	6
15	..	2	..
16	..	..	4
17	..	..	2
19	..	..	2
20	..	2	2
21	..	2	..
22	3	..	..
23	2	2	2
24	2	..	2
25	3	2	4
26	2	8	..
27	5	4	..
28	4	2	..
29	9	4	..
30	5	8	..
31	9	6	4
32	5	4	..
33	6	10	2
34	6	8	..
35	6	14	..
36	6	4	2
37	10	12	4
38	4	4	..
39	4	..	10
40	3	2	16
41	2	..	2
42	1	..	4
49	1	..	..
72	1	..	..
76	1	..	..

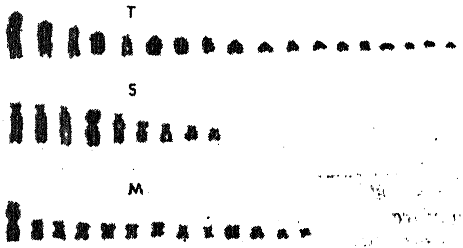

FIG. 2. Karyotype of the cells in the 111th generation. T, Telocentrics; S Sub-metacentrics; M, Metacentrics.

In the earlier studies, the Japanese workers have described Yoshida sarcoma as a near diploid tumour with forty elements as the modal chromosome number.[4] They have also described the establishment of a polyploid clonal subline with 80 chromosomes as the modal number which has maintained this character for over 200 transfer generations.[2]

Varied events have occurred during the transplantation of this tumour since the time of its discovery. Proliferation of a single clone by the transplantation of single cell, heterotransplantation in mice, preservation of cells in the cold, regeneration from a nodule day after the death of the animal, exposure to 60° C. for half-an-hour and chemicals, have all been reported during its maintenance. Sublines of Yoshida sarcoma with large number of chromosomes with marked slow down in growth accompanied by remarkable changes in the ascites characteristics of the tumour have been obtained.[5]

The present study indicates that no chromosome number is absolutely predominant in any one of the transfer generations. From karyological studies it is observed that even though the modal number in the 111th generation is 40, as in the original Yoshida ascites sarcoma, it is different in its chromosomal make-up by possessing more of the telocentrics and metacentrics whereas submetacentrics are less in number.

Variations in the modal number has occurred at the different transfer generations. The tumour appears to be undergoing a continuous change in its chromosomal constitution, though transplantation is being done in isogeneic strains of rats and has not yet attained stabilization.

In spite of these chromosomal variations there has not been any noticeable difference in the character of the tumour development and its progression,[6] thus confirming the general observation that visible chromosomal changes may not always reflect change in biological activity.

---

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BIOCHEMICAL CHANGES IN RELATION TO THE BREEDING CYCLES OF *NAUSITORA HEDLEYI* SCHEPMAN (BIVALVIA : TEREDINIDAE)

M. SARASWATHY*
Oceanographic Laboratory, Cochin-16

AND

N. BALAKRISHNAN NAIR
Marine Biological Laboratory, University of Kerala, Trivandrum-7

THE present study was initiated to elucidate the general biochemical make up of *Nausitora hedleyi*—a typical estuarine boring bivalve and more specifically to determine whether systematic variations of any of the constituents might be correlated with the annual reproductive cycle. The estimations have been made on entire animals only, collected from the Cochin Backwaters for a period of twelve months. All biochemical estimations were done on material dried to constant weight. Water content, ash content, glycogen, protein, total nitrogen and non-protein nitrogen, lipids, calcium, phosphorus and chloride content were estimated. Glycogen estimation was done according to the method outlined by Mendel and Hoogland and adopted by Raymont and Krishnaswamy[1] and expressed as percentage of glucose in dry

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* Present Address : National Institute of Oceanography, Cochin-18.

tissue. For determination of the total nitrogen content, the conventional method of micro-kjeldahl distillation as outlined by Steyermark[2] was followed and for lipids Soxhlet apparatus was used. The method of A.O.A.C.[3] was followed for the determination of salts, ash content, calcium and phosphorus.

The data representing average values are delineated in Figs. 1 and 2. The water content varied from 57·04 to 83·60%. An inverse relationship between the water content of the body and the salinity of the ambient water was evident (Fig. 1). It was also observed that the water content of the body of females was higher than that of males and that the range of fluctuation was more conspicuous in females than in males. Glycogen is an important food reserve of many marine molluscs needed for reproduction, growth and maintenance. Glycogen values were considerably high during the non-breeding months especially during February to May when they fluctuated between 33·35% and 52·22% of the dry weight of the animal (Fig. 2). From June to January the values were comparatively low. On the onset of the breeding season there was a perceivable fall in the glycogen content, probably owing to the initial mass spawning during June. After January the values were comparatively high and reached the highest value for the year in March. The protein content was generally high during the period June to January. The total nitrogen values were apparently steady both during the breeding as well as during the non-breeding periods. The values for non-protein nitrogen indicate that in general this constituent was poor during a major part of the breeding season.

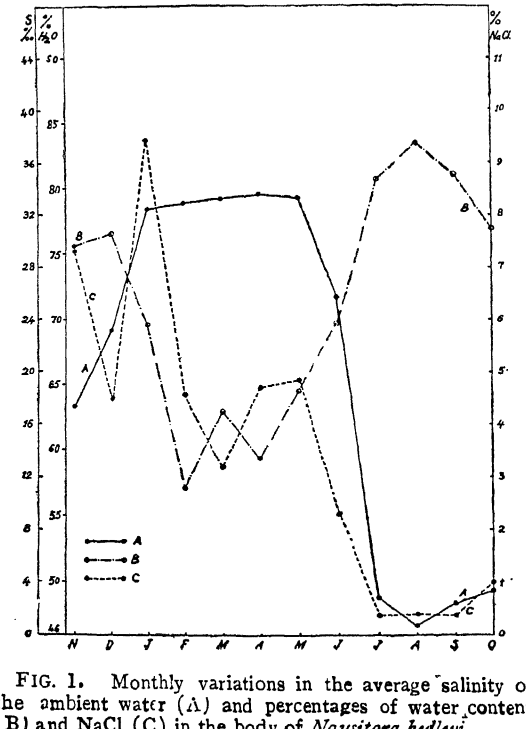

FIG. 1. Monthly variations in the average salinity of the ambient water (A) and percentages of water content (B) and NaCl (C) in the body of *Nausitora hedleyi*.

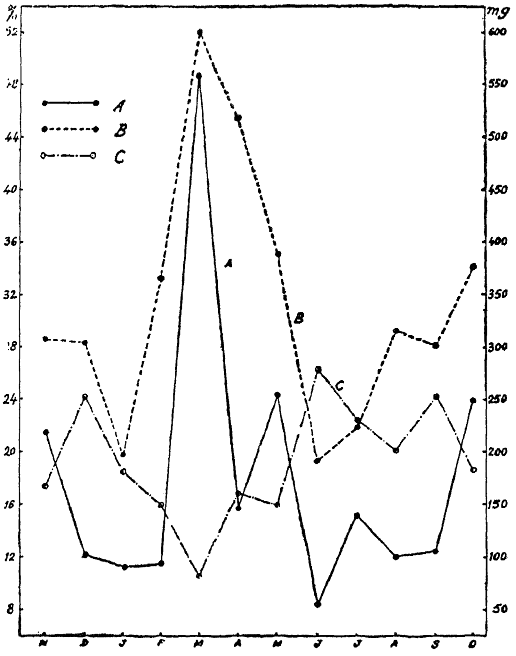

FIG. 2. Monthly variations in the average dry weight of specimens (A), parcentage of glycogen (B) and protein content (C) in the body of *Nausitora hedleyi*.

To find out the relationship regarding glycogen, protein and total nitrogen content of this species to the dry weight, the specimens were arranged into groups with a weight difference of 50 mg. irrespective of any considerations of sex, time of collection or length. The average glycogen content of ship-worms below 50 mg. dry weight was about 23·17% and the values showed a steady increase without appreciable fluctuations to reach a value which represented more than 50% of the entire dry weight of the animal in specimens above 400 mg. weight. In this estuarine species glycogen in terms of per cent. dry weight is higher than that in such wood boring bivalves as *Teredo pedicellata*,[8,9] and *Martesia striata*[4] or in oysters.[5] The protein content of animals in the weight group 0·50 mg. was found to be highest and this constituent continued to be high until about the weight group 250 to 300 mg. with an average protein content of about 18% of dry weight. Protein had also as high a value as 23·51 in the lowest weight group. In specimens above 400 mg. this constituent was found to be even less than 50% of the protein content noticed in the smallest weight group. The total nitrogen content of animals had a similar trend to that of protein with the highest values in the smallest weight group. An inverse relationship was noticed between glycogen and nitrogen and a direct relationship between nitrogen and protein.

The lipid content expressed in terms of percentage of dry weight varied from 3·46 in June to 8·34 in November. Lipid values were comparatively low during April, May and June. A distinct correlation between lipid content and breeding period was, however, not very evident in this mollusc. In *N. hedleyi* lipids constitute only a small percentage of the dry weight unlike in forms like chitons[10] where this constituent was found to reach levels of 29% of the total dry weight in some organs. The percentage of salts (chlorine as sodium chloride) expressed as percentage of dry tissue showed a distinct fall on the onset of breeding season which in this case coincided with a fall in salinity of the ambient water. During the highly saline period of February, March and April the salt content of the body was curiously low. The ash content expressed as percentage of dry weight varied from 4·68 in July to 11·45 in June. This shows that there is a noticeable fall of the ash content soon after the onset of breeding. On an average the amount of ash in this species is about 8·12% of the dry tissue thus falling within the usual range noticed in mature molluscs. The calcium content of the species expressed as percentage of the ash content fluctuated between 7·1 in November and 22·48 in August. The values were comparatively high during July, August and September and were low during October and November.

A similar trend was noticed in respect of phosphorus content of this mollusc. However, the amount of phosphorus present seems to be much less than calcium. The data regarding the mineral constituents give the impression that coinciding with the period of spawning and the consequent loss of weight owing to a fall in the organic constituents, there is an apparent increase in the calcium content of the body as has been reported in the case of oysters.[7] From the above study of the variations in the chemical composition of *N. hedleyi* it may be seen that there are two distinct periods of variation, the first extending from June to December, which is the season when there is breeding activity and the other extending from January to May representing a period of rest. These periods are characterised by the variation in the chemical composition. In the first period the values for water content, protein, total nitrogen and in general for calcium and phosphorus are high while in the second period glycogen and non-protein nitrogen show an increase with an apparent fall in the percentage of the constituents which showed higher values during the first period. Thus an interesting correlation is noticeable with regard to the breeding season and the chemical composition in this species.

Thanks are due to Dr. M. Sukumaran, Professor of Biochemistry, Medical College, Trivandrum, for affording necessary facilities for carrying out this investigation.

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LETTERS TO THE EDITOR

PHOTOELECTRIC CROSS-SECTIONS OF 192 keV GAMMA-RAYS IN Ta AND Cd

ABSTRACT

Photoelectric cross-sections of 192 keV gamma-rays are determined by the method of Internal-External Conversion Technique, using a scintillation spectrometer. The results are found to be in agreement with the available theoretical and compiled data within the range of errors.

THEORETICAL photoelectric cross-sections in the energy region from 0·1 keV to 3 MeV from Al to U were reported by Schmickley and Pratt.[1] They compared their results with the available experimental results in the energy region 320 keV to 2662 keV and found satisfactory agreement. In a previous investigation of the authors[2] photoelectric cross-sections of 280 keV gamma-rays were determined utilising the Internal-External Conversion Technique and the results were found to be in satisfactory agreement with theoretical values. In the present investigations photoelectric cross-sections of 192 keV gamma-rays are determined utilising a similar technique,[2] with a scintillation spectrometer.

An In^{114m} source obtained from the Bhabha Atomic Research Centre is employed. Utilising a well-type plastic scintillator the total beta spectrum is taken. A strong conversion line with its peak situated at an energy ~ 175 keV is located over a beta continuum. The decay scheme of In^{114m} shows predominant isomeric transition of 192 keV with a beta group of end-point energy 1·98 MeV in cascade. The other beta groups, positron emission, and gamma-rays are small in intensity when compared to the mentioned transitions. The conversion line is superposed over the beta group of 1·98 MeV. The recorded pulse height spectrum is transferred first into the corresponding energy distribution and then into that of a momentum distribution since in such a distribution, the beta continuum starts from the origin. The continuum is smoothly extrapolated to the low momentum side to the origin. This extrapolation is again transferred back into the original pulse height distribution. The area bounded by the conversion peak and the extrapolated curve is taken, with necessary corrections as the conversion electron intensity. Making use of the conversion coefficient measured by Hoffman[3] the gamma-ray intensity is determined from the conversion electron intensity. It may be noted in this connection that the conversion coefficient used in the present investigations is measured by peak to beta spectrum method but not by the Internal-External Conversion Method, employing the theoretical photoelectric cross-section.

The plastic scintillator used being a well-type of sufficient depth, reliably records the photoelectron intensity. Foils of thickness 8·73 mg./cm.^{2} (Ta) and 11·97 mg./cm.^{2} (Cd) were used. The photoelectron intensity is measured by the aluminium difference technique as already described in the previous investigations.[2]

Making use of the measured gamma intensity, photoelectron intensity and number of atoms per unit area of the foil, the photoelectric cross-sections are determined in Ta and Cd. These values along with the theoretical values of Nagel,[4] Schmickley and Pratt,[1] and compiled values of Grodstein[5] and Hubbell and Berger[6] are given in Table I. It may be noted that all the theoretical and compiled values are obtained by interpolations. Therefore, the estimated errors in these values are higher than those reported in the available data.

It can be seen from Table I that there is satisfactory agreement between the present values and all the other theoretical and compiled data within the range of errors.

TABLE I

Photoelectric cross-sections of 192 keV gamma-rays in barns per atom

		Ta	Cd
Present Experimental Values	..	211 ± 16	38·0 ± 3·0
Values of Grodstein	..	205 ± 10	38·0 ± 2·0
Values of Nagel	..	205 ± 6	..
Values of Hubbell and Berger	..	201 ± 8	38·0 ± 1·0
Values of Schmickley and Pratt	..	209 ± 2	38·0 ± 0·4

The Laboratories of Nuclear Research,
Andhra University,
Waltair, *November* 23, 1968.

M. RAJA RAO.
K. PARTHASARADHI.
SWAMI JNANANANDA.

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X-RAY DETERMINATION OF THE COEFFICIENTS OF THERMAL EXPANSION OF MAGNESIUM CARBONATE

THE sample used in this investigation is prepared from a clear crystalline mineral. The powder pattern of the sample showed no extra lines due to impurities. Using a Unicam 19 cm. powder camera and Cu radiation from a Raymax 60 unit, the powder photographs were taken in the temperature range 30° C. to 415° C. The experimental details and the method of evaluating the precision lattice parameters and the coefficients of thermal expansion have been described in an earlier paper.[4]

The lattice parameters at different temperatures are given in Table I and shown graphically in Fig. 1. The lattice parameters obtained in the present investigation are compared with the earlier values in Table II. The coefficients of thermal expansion at different temperatures are shown graphically in Fig. 2. Using the least squares method, the temperature dependence of the coefficients of expansion is represented by equations (1) and (2).

TABLE I

Cell constants of $MgCO_3$ at various temperatures

Temperature ° C.	a Å	c Å
30	4·6342	15·0245
89	4·6363	15·0406
165	4·6401	15·0711
217	4·6424	15·0914
267	4·6432	15·1038
315	4·6444	15·1224
415	4·6474	15·1537

$$\alpha_{\parallel} = 22 \cdot 326 + 0 \cdot 335 \times 10^{-8} t - 6 \cdot 976 \times 10^{-12} t^2 \quad (1)$$

$$\alpha_{\perp} = 9 \cdot 443 - 0 \cdot 915 \times 10^{-8} t + 3 \cdot 847 \times 10^{-12} t^2 \quad (2)$$

where t is in ° C.

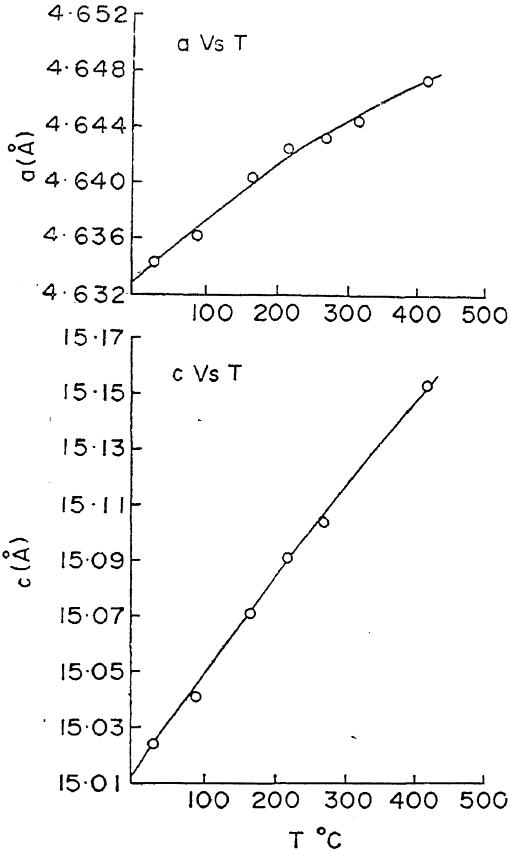

FIG. 1. Lattice parameters of $MgCO_3$ at different temperatures.

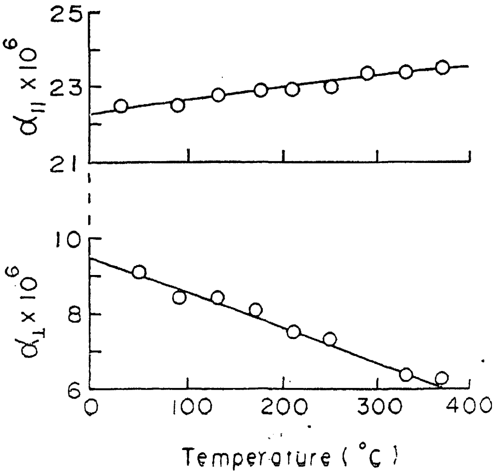

FIG. 2. Temperature variation of the coefficients of expansion of $MgCO_3$.

TABLE II
Cell constants of $MgCO_3$ at room temperature

Authors		a Å	c Å
Schoklitsch[2]	..	4·604	14·940
Goldsmith and Graf[3]	..	4·6331	15·016
ASTM	..	4·6332	15·015
Present study	..	4·6336 ±0·0003	15·0220 ± 0·0010

The coefficients of thermal expansion obtained in the present investigation are compared with Fizeau's values[1] in Table III. There is good agreement between the values of $\alpha_{\parallel}$ but the present value of $\alpha_{\perp}$ is slightly higher than Fizeau's value.

TABLE III
Comparison of the thermal expansion coefficients of $MgCO_3$

Authors		Method	$\alpha_{\parallel} \times 10^6$	$\alpha_{\perp} \times 10^6$
Fizeau. H[1]	..	Interferometer	22·65	6·96
Present study	..	X-ray	22·46	8·80

A comparison of the coefficients of thermal expansion of the calcite-type compounds, so far studied, is made in Table IV. The behaviour of magnesium carbonate is similar to the other compounds in having a large coefficient of expansion along the c-axis which is normal to CO_3 layer and a small coefficient of expansion in the perpendicular direction. Calcite and potassium nitrate have negative values for $\alpha_{\perp}$.

TABLE IV
Thermal expansion coefficients of calcite type compounds

Authors	Compound	Method	$\alpha_{\parallel} \times 10^6$	$\alpha_{\perp} \times 10^6$
Fischmeister[5]	$LiNO_3$	X-ray	34	103
Fizeau[1]	$FeCO_3$	Interferometer	6·85	20·22
Fischmeister[5]	KNO_3	X-ray	− 8	308
Krishna Rao *et al.*[4]	$CaCO_3$	,,	− 3·7	25·6
Kantola *et al.*[6]	$NaNO_3$	,,	11·5	120
Present study ..	$MgCO_3$	,,	8·8	22·5

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Dept. of Physics, K. V. KRISHNA RAO.
Osmania Univ., K. SATYANARAYANA MURTHY.
Hyderabad-7,
October 23, 1968.

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HAEMOGLOBIN OF *ANISOPS NIVEUS* (NOTONECTIDAE, HETEROPTERA)

OCCURRENCE of iron-linked pigment hæmoglobin in freshwater insects notonectids (Notonectidæ, Heteroptera) is well known. It is located in cytoplasm of tracheal cells (25–30 μ in diameter) occurring in bunches near ventral abdominal spiracles. In this communication, the spectrophotometric properties of the hæmoglobin extracted from *Anisops niveus* Fabr. are discussed.

Notonecta, the back swimmers, are almost universally distributed and are extremely predacious, feeding not only on plankton but also on larvæ and fingerlings of major carps. In Bombay, quite a few species of these are found in fish nurseries. *Anisops niveus*, one of the common species, was collected from Bandra fish nursery. The specimens were washed in filtered tap-water and the hæmoglobin was extracted by squeezing them through muslin cloth. The crude extract thus obtained was centrifuged, frozen, thawed and filtered. The pigment was next purified by absorption on calcium phosphate gel, and eluted in M/15 phosphate buffer (pH 7·0). The absorption spectra of oxyhæmoglobin and derivatives were measured, using a Beckman DU 2 spectrophotometer. The oxyhæmoglobin, prosthetic group. and derivatives, were prepared as described earlier.[1–3]

Table I records the position of absorption maxima of *Anisops* oxyhæmoglobin and deri-

TABLE I
Positions of absorption maxima (mμ) *of* Anisops *oxyhæmoglobin and derivatives*

Derivative		Absorption maxima (mμ)			
Oxyhæmoglobin	..	414–15	574	540	..
Reduced hæmoglobin	..	432	558	..	..
Nitric oxide hæmoglobin	..	415	565	540	..
Acid porphyrin	..	408–10	560	..	..
Hæmin in acid acetone	..	385–86	638	538	510
Pyridine hæmochrome	..	418	557	526	..
Denatured globin hæmochrome		..	557–58	527	..

vatives. The oxyhæmoglobin spectrum has the α peak at 574, β at 540, Soret peak at 414–15 and a band due to protein at 280–82 mμ (Fig. 1). This agrees well with those reported for various invertebrate hæmoglobins.[1-3] The ratios of optical densities at α : β and β : minimum were 0·817 and 1·55 respectively. These are rather low compared to those reported for several invertebrate oxyhæmoglobins. The decrease in these ratios may be due to the oxidation of O_2Hb, which invariably occurred during the extraction of the pigment. The ratio of optical density at α peak : Soret was 0·107, which agrees well with those reported for other hæmoglobins. The oxyhæmoglobin when treated with a pinch of solid sodium dithionite changed its colour, and the product gave absorption spectrum with a single broad band with a peak at 558 mμ similar to the reduced hæmoglobin of other invertebrates. Other derivatives of hæmoglobin, namely, nitric oxidehæmoglobin, acid porphyrin, hæmin in acid acetone, pyridine hæmochrome (Fig. 1) and denatured globin hæmochrome showed typical absorption curves analogous to corresponding derivatives prepared from the hæmoglobins of other forms. This suggests that same type of protohæmin is linked to protein in *Anisops* hæmoglobin as in other species.

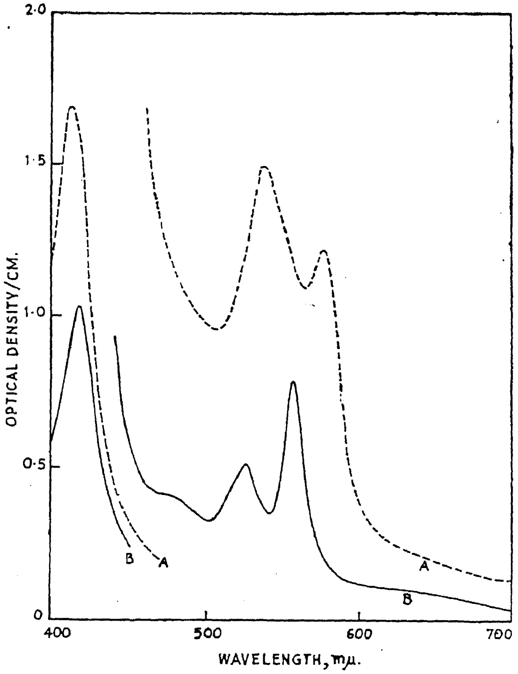

FIG. 1. Absorption spectra of (A) oxyhæmoglobin in M/15 phosphate buffer (PH 7) and (B) Pyridine hæmochrome of *Anisops niveus*. For measurement in Soret region solutions were conveniently diluted.

The occurrence of hæmoglobin in tracheal cells in these forms could be explained in terms of pigment's active role as oxygen carrier, and further possibly the dissociated oxygen is added to the air store between the plastron hairs and used in maintaining the pressure in the bubble around, and so the buoyancy of the insect.

Our thanks are due to Dr. A. K. Ganguly for his interest and to Mr. B. F. Chhapgar of Taraporevala Aquarium, Bombay, for supply of material.

Bhabha Atomic S. PATEL.*
Research Centre, B. PATEL.
Health Physics Division,
Bombay-85,
November 9, 1968.

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* Research Fellow, NISI.

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HEMOGLOBIN TYPES IN LOCAL AND IMPORTED CATTLE BREEDS OF ISRAEL

ABSTRACT

The hemoglobin types of local and imported dairy and beef cattle breeds and crossbreeds of Israel were studied. The breeds and crossbreeds showed one or more of the three previously reported adult bovine hemoglobins. The Local (Oksh) and Damascus breeds showed both type A and B hemoglobins. Crossbreeds of Local cattle and European dairy or beef breeds had lower gene frequencies for Hb-B than the pure Local cattle.

CONSIDERABLE attention has been drawn to th hemoglobin pattern in animals. The fiv distinct types of hemoglobin which have bee established are designated: A, B, AB, C an F hemoglobins. However, F hemoglobi appears only in young calves. The Britis breeds possess only hemoglobin A, except th Jersey, Guernsey and South Devon breed which contain also hemoglobin B. Thos animals which seemed to be heat tolera possess also a relatively high gene frequenc for the fast moving hemoglobin B.

TABLE I

Hemoglobin types in different cattle breeds and crossbred, and comparison to previous reports

Breed	No. of animals	Genotype AA	Genotype AB	Genotype BB	Gene frequency for Hb-A	Gene frequency for Hb-A in previous reports	References
Afrikaner ..	3	3	..	..	1·00	0·87	(2) Evans (1963)
Brahman ..	3	..	3	..	0·50	0·66 0·53	do. (4) Salisbury (1957)
Bush ..	9	9	..	..	1·00	..	..
Charollais ..	4	4	..	..	1·00	0·92	(7) Bangham (1958)
Damascus ..	6	4	1	1	0·75	..	..
Friesian ..	10	10	..	..	1·00	1·00	(8) Rullinson (1963)
Hereford ..	14	14	..	..	1·00	1·00 0·98	(3) Bangham (1957) (2) Evans (1963) (4) Salisbury (1957)
Local (Oksh) ..	23	18	5	..	0·89	..	
Santa Gertrudis ..	13	11	2	..	0·92	0·93 (Not all were purebred)	do.
Charollais × Local (Oksh) ..	9	8	1	..	0·94	..	..
Hereford × Damascus ..	4	3	1	..	0·88	..	..
Hereford × Local (Oksh) ..	9	9	..	..	1·00	..	..

These observations stimulated investigation on the possibility of tracing the origin of cattle breeds, and the interrelationships of hemoglobin types and other physiological characters of cattle breeds. In the present study the hemoglobin types obtained from local and imported dairy and beef cattle breeds and crossbreeds were studied in relation to the hot and dry climate of Israel.

Blood samples were collected from 117 healthy adult cattle of different breeds and sex. Heparin was used as an anticoagulant. The red blood cells were washed three times with a 0·9% NaCl solution by centrifugation and lysed with distilled water. A final 1% hemoglobin solution was then adjusted from the hemolysate and chloroform was added to collect the cell debris at the interface after centrifuging.

Paper electrophoresis analyses were performed in a Grassman horizontal type chamber. Tris borate buffer (4·6 gm. boric acid, 60·5 gm. tris, final volume 1 l.) pH 9·1 was used. A Whatman No. 3 mm. filter-paper 4 × 25 cm. served as a carrier and the samples were run for 3 hr. at 230 volts.

As shown in Table I and Fig. 1, the examined breeds and crossbreeds showed either, hemoglobin A (mean migration distance 34 mm.), B (mean migration distance 47 mm.) or AB. The hemoglobin C reported in the literature was not observed.

The Afrikaner, Busa, Charollais, Friesian, Hereford and Hereford × Local (Oksh) breeds and crossbreeds exhibited type A hemoglobin with a gene frequency of 1·00, while the Damascus, Local (Oksh), Santa Gertrudis,

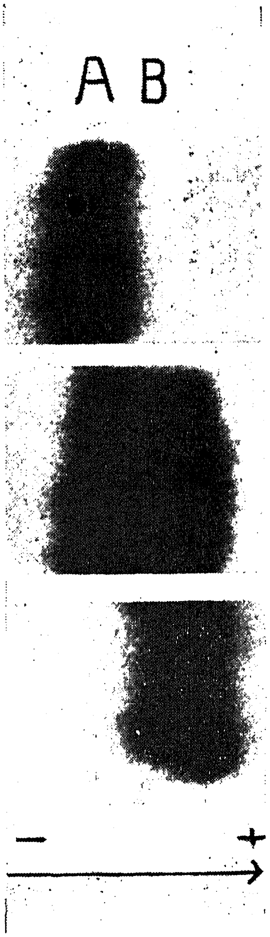

FIG. 1. Hemoglobin types established by paper electrophoretic technique from local and imported breeds and crossbred of Israel.

Charollais × Local (Oksh) and Hereford × Damascus breeds and crossbreeds showed in addition to A, also B and AB hemoglobins. In the Brahman breed only hemoglobin AB (with gene frequency of Hb-A = 0·50) was found.

The data presented in this experiment are in general agreement with those reported by other authors (Table I). Due to the small number of animals, the demonstration of all the hemoglobin genotypes in the Afrikaner, Brahman and Charollais breeds were incomplete, however the gene frequencies for Hb-A were compatible with those cited from the literature. The Friesian, Hereford and Santa Gertrudis breeds showed hemoglobin phenotypes with gene frequencies like those accepted before.

The paper electrophoretic of Local (Oksh), Damascus, Busa, Charollais × Local (Oksh) breeds and crossbreds have not been reported. The Busa cattle imported to Israel from Europe (Yugoslavia) showed only hemoglobin A. The Local (Oksh) and the Damascus cattle breeds, were bred for many generations in this country. Due to their adaptation to hot and dry climate, they were used mainly for crossbreeding with imported high grade European beef and dairy cattle. However, no significant clinical and hematological differences were found between the crossed and pure European cattle breeds[1] (Herz, 1967).

All but one of the pure Damascus and Local (Oksh) breeds or crossbreds indicated the presence of hemoglobin A and B, but the gene frequencies for hemoglobin B were higher in the pure Local and Damascus breeds in comparison to the crossbreds.

It was stated before that those animals which appear to be heat-tolerant are also those with a relative high gene frequency for Hb-B.[2] The same results were found in this experiment. The Brahman, Damascus and Local (Oksh) breeds had higher gene frequencies for Hb-B. However, the Charollais × Local (Oksh) crossbreds had lower gene frequency for Hb-B than the Local breed. The Hereford × Damascus had lower gene frequency for Hb-B than the Damascus, and the Hereford × Local (Oksh) crossbred had no Hb-B. This might explain the insignificant differences found between the crossed and pure European breeds, in adaptation to hot and dry climatic conditions.

Previous studies have shown that with the exception of the Jersey, Guernsy and South Devon breeds, all British breeds possessed only Hb-A.[3-5] The appearance of hemoglobin B in the Jersey cattle made a few authors[3,6] to suggest an hypothesis tracing the origin of Jersey breed from Indus Valley, through Mesopotamia, Egypt, North Africa and southern Spain. This, if true, might explain the appearance of hemoglobin B along the line of migration, including the hemoglobin which was found in the Local cattle breeds of Israel.

Department of Anatomy and Physiology,
The Hebrew University,
Rehovot, Israel,
October 23, 1968.

I. HOD.
A. HERZ.

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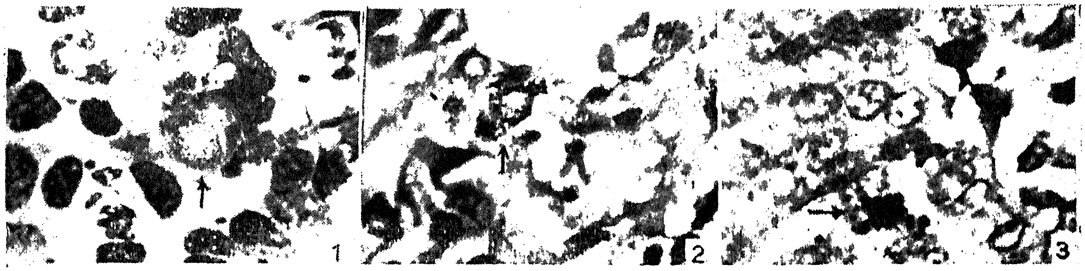
CAPRINE PNEUMONITIS CAUSED BY A VIRUS OF *PSITTACOSIS LYMPHOGRANULOMA* VENERUM (PLV) GROUP

McKERCHER[1] reported pneumonia of sheep caused by a virus of PLV group. The virus was isolated from pneumonic lungs of five sheep which were free from bacteria of pathogenic significance. Saito *et al.*[2] reported the occurrence of similar pneumonia in goats in Japan.

In India, Rajya and Singh[3] reported the occurrence of inclusions similar to those of PLV virus, in some cases of jagziekte in sheep and goats. Longley[4] suspected the association of a virus in some cases of caprine pneumonia.

In the present investigation, a virus, possibly belonging to PLV group was isolated from cases of viral pneumonitis in goats, while conducting studies on the pathology of pulmonary adenomatosis complex in sheep and goats.

For isolation of the virus, the method followed by Matumato *et al.*[5] was used. Three pooled samples of pneumonic goat lungs, suspected to be caused by PLV virus, were used for virus isolation in guinea-pigs. A



FIGS. 1-3. Fig. 1. Granular intracytoplasmic PLV elementary body in guinea-pig spleen, 7 × 100. Fig. 2. Granular coccoid PLV inclusions in the goat lung, 7 × 100. Fig. 3. Inclusions in the bronchiolar epithelium of goat lung, 10 × 100.

10% saline suspension of the pneumonic lungs was prepared to which streptomycin was added at the rate of 5 mg. per ml. of suspension. Centrifugation was done at 3000 rpm for 20 minutes and the supernatant was inoculated intraperitoneally at the rate of 2 ml. into each guinea-pig. A suitable number of control guinea-pigs were similarly injected each with 2 ml. of normal saline. Rise of temperature from 102° in early passages to 104° and above, in the subsequent passages was recorded on 4th day or later, after inoculation. Temperature in the control guinea-pigs remained within the normal range (below 101·5°). At autopsy the spleens of inoculated guinea-pigs were found enlarged to 2-4 times the normal size. Spleens were harvested for further passages. Impression smears of spleen of the inoculated guinea-pigs, revealed the presence of homogeneous eosinophilic plaques or granular, intracytoplasmic elementary bodies, by Giemsa and less suitably by Macchiavello stains (Fig. 1).

The characteristic histopathological changes seen in the cases of viral pneumonitis of goats were epithelialization of the alveolar walls, proliferation and desquamation of large number of epithelial cells and macrophages into the alveolar lumen, peribranchial and perivascular lymphocytic cuffing and lymphoid hyperplasia. Atelectasis was seen in some cases. Similar lesions were seen in some cases of pneumonia in sheep.

An attempt made to demonstrate the presence of PLV inclusions in some sections of pneumonic goat and sheep lungs by Giemsa and Macchiavello methods, revealed red coccoid, intracytoplasmic inclusions in the lung parenchyma and sometimes in the branchiolar epithelium (Figs. 2 and 3). Inclusions could not be seen in all the suspected cases, which could be due to the fact that the inclusions are generally not seen after fourth day of infection in the natural host (Dungworth and Cordy).[6]

The authors are grateful to Dr. Saito of Kitasato Institute of Infectious Diseases, Japan, who confirmed our findings on examining some of our slides referred to him and to Shri N. S. Parihar for his help.

Indian Veterinary
Research Institute,
Izatnagar (U.P.),
October 28, 1968.

H. V. S. CHAUHAN.
C. M. SINGH.

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OCCURRENCE OF FERRIFEROUS ORTHOCLASE PORPHYROBLASTS FROM RAZAM, SRIKAKULAM DISTRICT, A.P.

THE present note deals with the occurrence of ferriferous orthoclase from pyroxene-bearing granitic rocks near Razam (N. Lat. 18° 27′ and E. Long. 83° 40′). Srikakulam District, A.P. Previously, Coombs[1] described ferriferous orthoclase from Madagascar.

The ferriferous orthoclase is observed as porphyroblasts measuring in size about 2 to 3 inches in length with a maximum width of about 1 to $1\frac{1}{2}$ inches. There are also a few grains associated with quartz, plagioclase ($An_{25,35}$), pyroxene (hypersthene-ferrohypersthene), biotite, and opaques in the ground-mass. Under the microscope, the mineral appears homogeneous, without observable perthites. The mineral shows one set of cleavages (001), the optic axial plane is perpendicular to (010), and $2V_{\alpha}$ is varying between 40° and 47°, the average being 44°.

For analysis, the porphyroblasts were separated from the hand-specimen and ground to fine powder. The − 120 + 170 mesh powder was taken, and after removal of the magnetics by a hand magnet, it was passed through an isodynamic separator 4 to 5 times to remove any ferromagnesian minerals present. The mineral was further separated using heavy liquids and final separation was done using a binocular microscope. Two partial analyses of the mineral are given in Table I.

TABLE I

		I*	II†
Fe_2O_3	..	0·97	1·82
CaO	..	1·13	1·05
Na_2O	..	0·75	0·50
K_2O	..	14·82	14·82
% Fe orthoclase	..	3·68	6·16

* From Nandabalaga, about 3½ miles south of Razam, † From Duvalapeta, about 1 mile north of Razam.

The X-ray diffractometer studies using $CuK\alpha_1$ radiation ($\lambda = 1·54050$) on these two samples showed almost identical patterns, and data on the sharp lines observed are given in Table II.

TABLE II

d	I/I_1	h k l
4·227	18	$\bar{2}$ 0 1
3·948	14	1 1 1
3·782	34	1 3 0
3·624	10	1 3 $\bar{1}$
3·477	24	1 1 $\bar{2}$
3·312	40	2 2 0
3·229	100	0 4 0. 0 0 2
2·995	28	1 3 1
2·169	18	0 6 0

$a = 8·5\ 8$ Å, $b = 13·05$ Å $c = 7·201$ Å $\beta = 115·95°$
$V = 723·1$ Å^3, $A = 0·6591$, $C = 0·5533$.

The above data closely agree with the A.S.T.M. Card (8–48) data for ferriferous orthoclase.

It is suggested from the field and textural studies that the porphyroblasts are formed due to K-metasomatism; Fe^{+3} which replaces Al^{+3} in the structure may be derived from the associated pyroxene. Biotite and opaques (ilmenite and magnetite) are bordering pyroxene and in some cases the cleavage of the latter is continuing into biotite suggesting that biotite and opaques are derived from the pyroxene during K-metasomatism. Thus it appears that during K-metasomatism, small amounts of Fe^{+3}, and large amounts of Fe^{+2} and Mg^{+2} present in pyroxene are incorporated into ferriferous orthoclase, and biotite respectively.

One of the authors (R. D. R.) is grateful to C.S.I.R., New Delhi, for the award of a Senior Research Fellowship.

Department of Geology, R. DHANA RAJU.
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PRESENCE OF HAEMOCYANIN IN THE BLOOD OF A CENTIPEDE *SCUTIGERA LONGICORNIS* (CHILOPODA : MYRIAPODA)

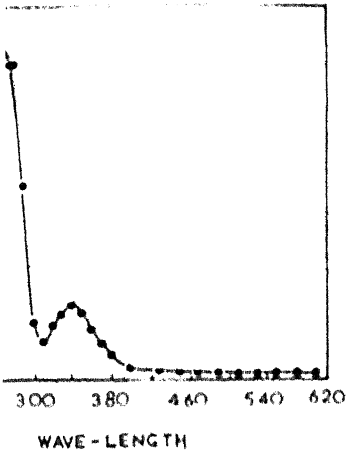
CENTIPEDES belonging to the order Scutigeromorpha differ from other groups of centipedes in having air-sacs and a number of short tracheal tubes which branch several times, and each of which ends in a blunt point of delicate cuticle that projects into the pericardial cavity where it is bathed in blood. The tracheæ are filled with air and ærate the blood, which in its turn ærates the tissues as in spiders.[1] Therefore, it would be of interest to investigate if the blood of scutigeromorph centipedes contain any respiratory pigment.

The material used was centipedes of the species *Scutigera longicornis* collected in the vicinity of Madras. The blood was extracted from a large number of centipedes in intermoult stage, through a puncture made on the mid-dorsal line of the body by means of a hypodermic syringe and used fresh for all the studies.

The presence of copper-containing pigments in the blood was tested by exposing wet smears of blood, on glass slides, over the vapour of ammonium sulphide.[2] The copper content of the blood was estimated quantitatively by the Biscyclohexane-oxylyldihydrazone method of Russel and Hart.[3] The optical density was measured using an Ilford No. 626 filter. Nitrogen content of the blood was estimated following the procedure outlined by Steyermark.[4] For spectrophotometric analysis, the blood was diluted 1 : 20.

The blood of *Scutigera longicornis* is normally faint indigo blue in colour and it is een exposed to the vapours of linie, suggesting the presence of ng pigments.[2] Estimation of shows that the blood contains 0·172% of the dry weight. ose to the 0·173% reported for nitrogen content of the blood , or 13·1% of the dry weight. indicate that the nitrogen-copper

A similar ratio has been e blood of a spider *Phormacto-* contains haemocyanin.[5] These suggest the presence of haemo- blood of *Scutigera longicornis*. its the absorption curve for the



tion curve of the blood of *Scutigera* ed by an Unicam spectrophotometer

centipede. The curve compares h the one obtained for the spider where it is said to indicate the emocyanin.[5] In the light of the ted above, it is suggested that the *gera longicornis* contains haemo-

is grateful to Professor G. his interest in the study. The rendered by Mrs. K. Lakshmi ment of Biochemistry, College of much appreciated.

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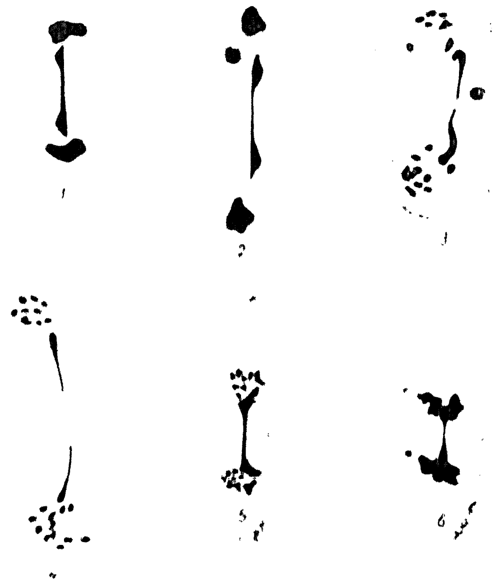
A NOTE ON THE OCCURRENCE OF CHROMATID BRIDGES IN THE MALE OF *ARTHROSPHAERA* SP., A PILL-MILLIPEDE

A FEW papers have appeared during recent years pertaining to the chromosome cytology of some Indian diplopods.[1-4] This paper refers to the occurrence of first meiotic chromatid bridges of a low frequency observed in the testes of an unidentified species of *Arthrosphaera*, a pill-millipede from the forest area of Mysore State.

The single chromatid bridges observed in the present case appear to be true bridges being the consequence of inversion cross-over (Figs. 1-6). They are thin and fine and have the appearance of stretched continuous chromatids. In some cases, the dicentric bridge was accompanied by an acentric fragment, but in others there was no indication of the existence of a chromosomal fragment. The fragments produced may be too small to be observed or may be displaced in squashes.



FIGS. 1-6. Different configurations of meiotic chromatid bridges in *Arthrosphaera* sp.

Our knowledge of chromosomal structural changes is limited to a few organisms. Originally, chromosomal rearrangements including inversions were supposed to be neutral biologically, but recent researches on "chromosomal polymorphism" have shown that they are not only active evolutionary agents, but also they confer certain advantages on the individuals.[5] The present instances of first division bridges probably represent the simplest type, which however point to the existence of two closely related genomes. More data is necessary to draw any conclusion of evolutionary significance of this mechanism operating in the populations of this species.

Thanks are due to Prof. B. R. Seshachar under whose guidance studies on diplopod cytology were initiated in this department.

Department of Zoology, B. N. CHOWDAIAH.
Central College,
Bangalore University,
January 13, 1969.

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THE STOMODAEAL NERVOUS SYSTEM OF *CYBISTER CONFUSUS* SHP. (DYTISCIDAE: COLEOPTERA)

THE stomodæal nervous system in insect consists of ganglia which are located above the stomodæal part of the alimentary canal and innervate the same. In literature, this system has also been referred to as Sympathetic, Visceral, Pharyngeal or Stomatogastric, but the term "*Stomodœal*" first proposed by Janet[1] and later accepted by Snodgrass[2] seems to be appropriate, since the ganglionic centres arise during embryonic development by ingrowths from the dorsal wall of the stomodæum.

The number and position of the nerves and the ganglia of the stomodæal nervous system is variable in insects, although there are a few fairly constant features, such as the presence of the frontal ganglion and the recurrent nerve. The terminology used in describing this system is complicated. Bickley[3] has recently reviewed work done on this system in insects.

Cybister confusus Shp. is a common, predator aquatic beetle found in Poona and environs, and this note gives an account of the stomodæal nervous system of this insect.

The frontal ganglion (*FG*) lies anterior and close to the brain (*BR*) and is connected by short and thick frontal ganglion connectives to the tritocerebrum. The recurrent nerve (*RN*) originating from the frontal ganglion runs backwards under the brain, on the dorsal wall of the pharynx and joins with the occipital ganglion (*OG*). The corpora cardiaca are not observed; it is possible that they are fused with the occipital ganglion, for there is a pair of nerves joining it to the brain. The paired corpora allata (*CA*) are also located under the brain and the nerves which join them to the occipital ganglion run under the brain. The median œsophageal nerve (*IN*) runs posteriorly from the occipital ganglion and joins with the ingluvial ganglion (*IG*) located on the dorsal wall of the posterior part of the crop that lies anterior to the gizzard (*G*) and the mesenteron (*M*). A pair of nerves extends posteriorly from the ingluvial ganglion.

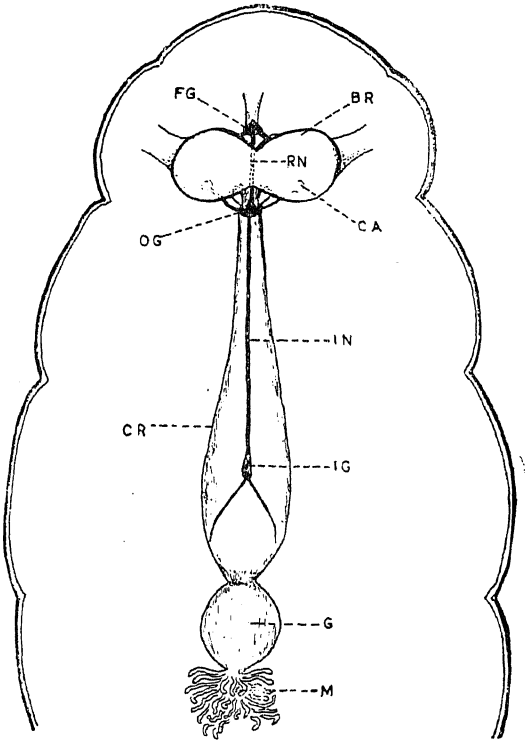

FIG. 1

I am grateful to Prof. L. Mulherkar for providing necessary facilities for the work and for the encouragement.

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D. R. RANADE.

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LOW LETHAL TEMPERATURES OF THE FISHES *LIZA MACROLEPIS* (SMITH) AND *TILAPIA MOSSAMBICA* PETERS

FRY and Associates[1-3] have made notable contributions in the field of temperature tolerance and resistance of fishes. While the high lethal levels of temperature of the group have been much explored there is more to be known about their low temperature deaths.[2] Results of preliminary experiments on low lethal temperatures of two species of fishes, *Liza macrolepis* and *Tilapia mossambica*, both of which occur together in the brackish waters around Mandapam and are being used for fish culture, are reported here.

Both the mullet and *Tilapia* were acclimated to fresh water at 30 ± 1° C for about two weeks before testing them. In all experiments, except in one, lots of 10 fish were exposed to cold temperatures by abrupt transfer from the water of acclimation to fresh water cooled to the test temperature (precision : ± 0·2° C) by adjusting the temperature inside a cold room. The water in the test tank was aerated to maintain adequate oxygen level.

The experimental fish (mullet : T.L.–5·5–12·5 cm.; *Tilapia* : T.L.–7·5–10·5 cm.) were exposed to three test temperatures, namely, 14·5, 16 and 18° C.

In Fig. 1 A and B plots of percentage of fish died (in probits) against logarithm of time to death in minutes at each test temperature are given. This method of studying lethal temperature relations, in terms of dosage-mortality results, has been justified by earlier workers and it has been shown that to plots as those in Fig. 1 usually straight lines can be fitted.[1,2]

None of *Tilapia* tested died within three days (longest test period) at 18° C, whereas at the same temperature all the mullets tested died within 2505 minutes. This fact and the comparison of the median lethal times (time to 50% mortality) as could be obtained from the figure clearly indicate that *Tilapia* is more resistant to cold temperatures than the mullet.

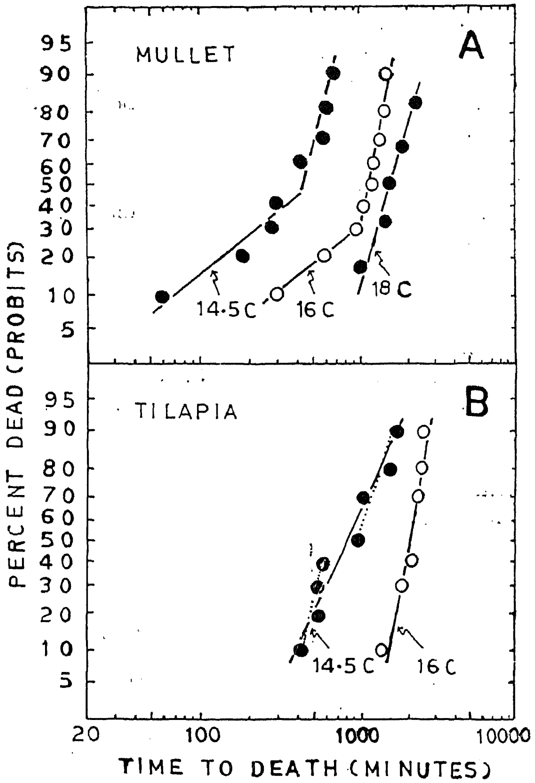

FIG. 1. Time to death at various low lethal temperatures in *Liza macrolepis* (A) and *Tilapia mossambica* (B). Both species were acclimated to fresh water at 30° C and tested in fresh water.

It may be noted that in Fig. 1 A, which shows the plots for the tests with mullet, scatters of points for tests at 16 and 14·5° C suggest that single straight lines cannot be fitted through as in the case of the points for 18° C. Therefore, two separate straight lines are drawn through the points for the lower temperatures, by inspection. Brett[2] also encountered similar phenomenon while dealing with low temperature deaths in salmonids and suggested that such split probits may be due to some factor besides temperature influencing the deaths of the fish. Brett showed that the factor in question could be salinity, the change in the rate of dying of the fish being caused by the failure of the osmoregulatory capacities. Salinity may be the factor involved in causing the split probits in the case of the mullets as well, which has to be verified by future tests. In Fig. 1 B the results of tests with *Tilapia* are given. It appears that a straight line can be fitted by eye examination to the points shown for the tests at both 14·5 and 16° C, even though as indicated by the dotted lines drawn through the values for *Tilapia* a split probit also could be indicated at 14·5° C. It is possible that in both species low temperature deaths are complex, being caused by more than one factor.

While information on the mechanism is itself of much value it may be pointed out that the differences in temperature tolerance and resistance among fishes, such as those shown here distinguishing *L. macrolepis* and *T. mossambica,* have been made use of as 'tools in taxonomy' in distinguishing taxonomic groupings.[3]

We are grateful to Dr. S. Jones for his interest and encouragement and Dr. J. R. Brett for his helpful suggestions.

Central Marine Fisheries Res. Inst.,
Mandapam Camp,
and
Department of Zoology,
Madurai University,
Madurai-2,
November 20, 1968.

M. NARAYANAN KUTTY.*
G. MURUGAPOOPATHY.

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* Present Address: Department of Zoology, Madurai University, Madurai-2.

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INFLUENCE OF ANTIBIOTICS AND pH OF PHOSPHATE BUFFER ON THE GERMINATION OF *BOTRYTIS* SPORES

AFTER detection of a phytoalexin type of reaction in the *Botrytis* infection of leaves of bean (*Vicia faba* L.)[1,2] it was thought worthwhile to investigate whether any bacterial product in the 'diffusate' was responsible for the inhibition of growth of the said pathogen. Initially an experiment was designed with a view to ascertain those concentrations of antibiotics which would not affect the germination of spores of *B. fabæ* and *B. cinerea* but would inhibit the growth of bacterial population in inoculum drops during incubation period. Besides, another experiment was also conducted to determine the optimal pH of phosphate buffer for the germination and germ tube growth of the test fungi.

Three different concentrations of streptomycin, aureomycin and chloramphenicol were prepared in sterile distilled water. They were diluted to 100, 200 and 400 p.p.m. by adding equal volumes of standardized spore suspension of either *B. fabæ* or *B. cinerea* prepared from 10 days old cultures grown on 'X' medium (10 gm. dextrose, 2 gm. peptone, 1·52 gm. KH_2PO_4, 6 gm. $NaNO_3$, 0·52 gm. $MgSO_4.7H_2O$, 0·52 gm. KCl, 3 gm. caseinhydrolysate (acid), 0·5 gm. yeast nucleic acid, 20 gm. agar agar, 1000 ml. distilled water). The spore suspensions were prepared following the method suggested by Deverall and Wood.[3] Four drops (20 µ l./drop-500 spores) of each concentration of antibiotic were placed on two clean slides on glass rods over moist filter-paper in a plastic box (7″ × 4½″ × 1½″) fitted with a lid. The lids of boxes were sealed with vaseline to reduce drying out of the drops and then incubated for 24 hrs. at 15–17° C. in 250 f.c. light. After incubation period, the spores were stained with 0·05% lactophenol-cotton blue and examined.

To determine the optimal pH for germination and growth of *Botrytis* spp., solutions with different pH values ranging from 5 to 8 were prepared by mixing appropriate volumes of KH_2PO_4 and K_2HPO_4 at a concentration of 0·01 M. This molarity was chosen as the highest favourable for unimpaired germination and germ tube growth of both fungi when their spores were tested in concentration of phosphate ranging from 1 M–10^{-3} M at pH 6. In this case germination was tested using hanging drop method. The spores were incubated for 24 hrs. keeping other conditions same as described earlier. The rate of spore germination of *B. cinerea* was found greater than *B. fabæ* in all the molar concentrations used. The germination rate of both fungi, however, declined in 10^{-1} M but markedly decreased at a concentration of 1 M.

The effects of different concentrations of antibiotics and pH range of phosphate buffer on the spore germination of the two species of *Botrytis* have been included in Tables I and II.

The germination rate of *B. cinerea* has been found to be much higher than that of *B. fabæ*. This result, however, substantiates the earlier findings of Deverall and Wood[3] who used the detached leaves of bean (*Vicia faba* L.) as media for spore germination of *Botrytis* spp. It appears from Table I that chloramphenicol 100 p.p.m. has little effect on germination of

TABLE I

:cts of different concentrations of antibiotics

Treatment	Concentration (p.p.m.)	% germination *B. fabœ*	*B. cinerea*
ile water :ontrol)	..	56·19 (1178–662)*	100 (870–870)
:ramphenicol	100	53·86 (1190–641)	100 (1000-1000)
	200	50·43 (1043–526)	100 (1057–1057)
	400	47·08 (1202–566)	100 (1079–1079)
eomycin ..	100	34·55 (1308–452)	24·19 (963–223)
	200	29·53 (1432–423)	3·54 (903–32)
	400	0 (1350–0)	2·99 (1034–31)
ptomycin ..	100	4·87 (1457–71)	0 (1067–0)
	200	0·75 (1330–10)	0 (1115-0)
	400	0·70 (1562–11)	0 (1053-0)

* No. of spores found—No. of spores germinated.

TABLE II

Effect of pH of phosphate buffer

	B. fabœ		*B. cinerea*	
I	Germ tube length* (μ)	% germination†	Germ tube length* (μ)	% germination†
	121·05	69·50 (305–212)	98·56	93·39 (454–424)
	168·07	73·94 (380–281)	124·17	97·88 (331–324)
	116·05	45·77 (308–141)	117·15	96·61 (532–514)
	41·39	9·91 (343– 34)	85·12	74·63 (339–253)

* Average length of germ tubes based on 60 spores.
† No. of spores found—No. of spores germinated.

fabœ and none on that of *B. cinerea*. But
ilar concentration of chloramphenicol can
eck the growth of a large number of bacteria
the inoculum drops. Streptomycin and
reomycin prevent the germination of both
igi to a considerable extent but *B. cinerea*
ems to be more sensitive. Of the three
tibiotics tested, 400 p.p.m. streptomycin is
ost effective in inhibiting the germination of
t fungi as well as bacterial growth.

It is evident from Table II that both fungi
rminate well between the pH 5–6. Although
cinerea spores germinate over a wide range
pH values from 5–8, *B. fabœ* shows
rupt fall in the germination rate above pH 7. The growth of germ tubes was also affected in a similar way to germination by different pH conditions.

Author wishes to express his sincere thanks to Dr. B. J. Deverall, Department of Botany, Imperial College of Science and Technology, London, for providing necessary facilities to carry out this investigation.

Department of Botany, R. P. PURKAYASTHA.
Visva-Bharati University,
Santiniketan,
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CHENOPODIUM PUMILIO R.Br.—AN ADDITION TO THE INDIAN FLORA WITH AN ENLARGED KEY TO THE SOUTH INDIAN SPECIES OF THE GENUS

THE genus *Chenopodium* L. (Chenopodiaceæ) is so far known to be represented by eight species in India,[2-5] of which three occur[2-4] in South India (region below Vindhyans). The species now identified as *Chenopodium pumilio* R.Br. was collected on June 1, 1968, from near Coonoor Railway Station, Ootakmund (Madras State). The plant grows in thin, narrow matrices along the rails and is so small and firm in the ground that it cannot be easily pulled out with hands. It is said to be a native of Australia and nearby regions[1] and hence an alien in this country. In the authors' knowledge, this species has so far been not recorded from India and hence an illustrated account of it is presented here, along with an enlarged key to the four species (including the present one) of the genus occurring in the South. The data bracketted in the description given below is after Brenan.[1]

Chenopodium pumilio R.Br., *Prodr. Fl. Nov. Holl.*, 1 : 407 (1810) ; Benth., *Fl. Austral.*, 5 : 163 (1870); Brenan, *Fl. Trop. East Africa* : 13 (1954). Type : Australia, R. Brown (BM, holo. K, iso. !).

A prostrate herb with radiating stems from the root ; stems branched or unbranched 2–30 cm. long (–45 cm.), green (rarely red-tinged), pubescent with cylindrical hair and capitate vesicular hair (*see* below for detail), aromatic. Leaves alternate, elliptic to lanceolate, small with coarse obscure teeth at margin or lobed, 0·2–0·8 × 0·1–0·3 cm. (0·3–2·7 × 0·2–1·3 cm.), petiolate to subsessile or some sessile; hairs confined to the lower surface on the veins. Flowers greenish, minute, about 0·2–0·5 mm. in diameter (0·4–0·75 mm.), sessile or subsessile in small axillary clusters in majority of the nodes. Sepals 4–5, valvate, with both the hair types. Petals absent. Stamen 1; anthers basifixed, longitudinally and laterally dehiscent. Stigmas two; style short; ovary superior, small, nearly rounded. Pericarp thin, dull-white, closely covering the seed (dehiscence not observed). Seed one, vertical, laterally compressed, deep reddish-brown, shining, 0·4–0·5 mm. (0·5–0·75 mm.) in diameter, bluntly or sharply keeled along the rim; testa nearly smooth, but when seen under 200 or above magnification, exhibits faint reticulate pattern; embryo annular, both its ends not meeting, enclosing the endosperm (Figs. 1–9).

Along the rails of Coonoor Railway Station (Ootakmund, Madras State), altitude about 1,700 m.: *Ramayya* s.n. (1st June 1968). Deposited at the Osmania University, Botany Department Herbarium=Hy. and at Kew Herbarium=K.

The plant might have escaped attention in the past due to its small size and unimpressive appearance.

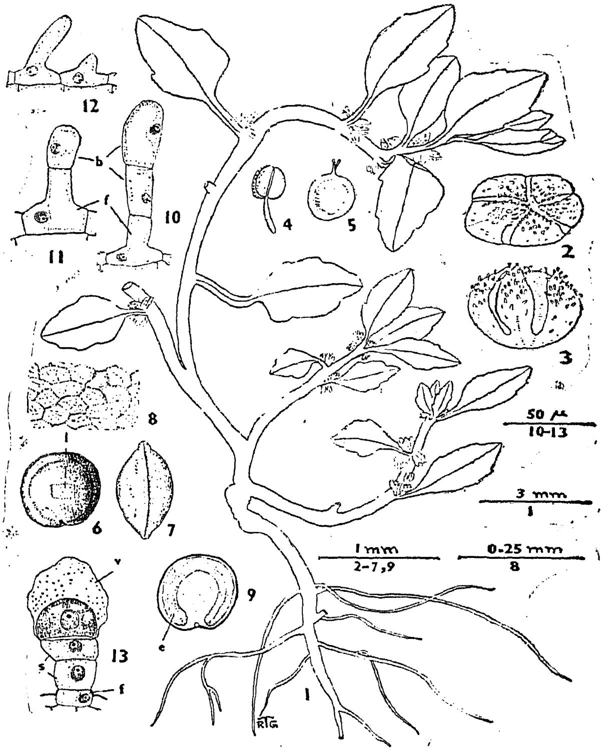
Distribution.—Native of Australia, also New Zealand, New Caledonia; said to be introduced along with wool into United States, Europe, and Britain and into Africa along with agricultural seeds (*cf.* Brenan[1]); at 1500–2530 m. high.

KEY TO THE SOUTH INDIA SPECIES

1. Plants erect growing above 40 cm. high; stamens 4–5.
    2. Stigmas 2; seeds almost black when ripe, embryo perfectly annular.
        3. Seeds sharply keeled on margin, testa marked with very close minute rounded pits,* pericarp very difficult to detach from seed; fœtid herb...... *C. murale* L.
        3. Seeds bluntly keeled on margin; (testa without rounded pits), nearly smooth, pericarp readily scraped from seed; scentless herb.........*C. album* L.
    2. Stigmas 3-5; seeds black to reddish-brown when ripe, testa almost smooth, embryo incompletely annulate; a tall erect much branched strongly aromatic herb........ *C. ambrosioides* L.
1. Plants spreading, with slender radiating stems growing up to 30 cm. long (40 cm.); stamen 1; stigmas 2; seeds deep reddish-brown, testa nearly smooth, embryo incompletely annular......*C. pumilio* R.Br.

Trichomes of C. pumilio

(*a*) *Cylindrical Hair*.—Foot: usually 1-celled. Body: uniseriate, 2-3-celled, cylindrical, rounded at the end. Cells longer than broad, with scanty contents; walls thin, smooth (Figs. 10, 11). Certain forms are reduced to short single-celled structures (Fig. 12). Distribution: major parts of the plant except the stamen and gynœcium.



FIGS. 1–13. *Chenopodium pumilio.* Fig 1. Habit. Figs. 2–3. Fruit with the enclosing persistent calyx, top and lateral view respectively. Fig. 4. Stamen. Fig. 5. Gynœcium. Figs. 6–7. Seed as seen in its horizontal an vertical positions. Fig 8. Testa surface pattern as seen a 200X. Fig. 9. Seed sectional view showing the annula embryo. Figs. 10–11. Cylindrical hair from the sepal margin Fig. 12. Cylindrical hair reduced to a single cell, fro the sepal margin. Fig. 13. Capitate vesicular hair fro the sepal abaxial surface. (*f* — foot; *b* — body; *s* —stalk *h* — head; *v* — vesicle; *e* — embryo.)

(*b*) *Capitate Vesicular Hair*.—Foot: 1-celle Stalk: uniseriate, 2-3-celled, slightly broadening above; cells broader than long; wall thin, smooth. Head: 1-celled, hemispherical, enclosed in a cuticular vesicle; contents dense; wall thin, smooth (Fig. 13). Distribution: as that of the above.

Our gratitude is due to Dr. J. P. M. Brenan, Kew Herbarium, for confirming our identification and matching the specimen with the isotype and to Prof. M. R. Suxena for facilities and encouragement. One of us (TR) is thankful to the Council of Scientific and Industrial Research, New Delhi, for the award of a Senior Research Fellowship.

Plant Anatomy and
Taxonomy Laboratory,
Department of Botany,
Osmania University,
Hyderabad-7 (India),
September 25, 1968.

N. RAMAYYA.
T. RAJAGOPAL.

---

* Surface pattern of testa is given as it appears under 20X.

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EFFECT OF PHOTOPERIOD ON FLOWERING IN *ANAGALLIS ARVENSIS* L. VAR. *COERULEA* GREN. *ET* GODR.

Anagallis arvensis occurs as a common winter annual of crop fields in India. Its earliest germination and seedling growth takes place in November to December when the daylength is shortest. Those plants, which germinate late in the season when days are lengthening, flower at an early vegetative stage. Thus the investigations reported here were carried out to ascertain the flowering response of this species towards different photoperiods.

Plants were raised from seeds in pots which were provided with 8-hour photoperiod during the first 10 days. After establishment the plants were given photoperiods ranging between 8 to 15 hours. Photoperiods longer than 10 hours were obtained by providing supplementary light from 200 watt incandescent lamp placed at a distance of about 1 m. above plant surface. For all treatments 5–8 plants, distributed in two pots, were used. Number of flowers and capsules produced were counted after 30 and 45 days after the establishment period. The data are presented in Fig. 1.

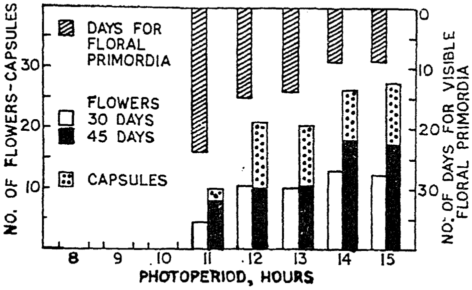

FIG. 1. Effect of photoperiods, varying between 8–15 hours, on flowering, capsule formation and number of days required for first visible floral bud.

No flowers were produced upto 10 hour-photoperiod. In the 11-hour photoperiod flowering is initiated to some extent, but more time is required for appearance of floral buds. It is evident that as photoperiod is increased above 12 hours, lesser number of days are required for initiation of flowering. Thus this species is a long-day plant with a critical photoperiod between 10–11 hours. In the first 30 days almost the same number of flowers are produced in photoperiods ranging between 12–15 hours, but later on longer photoperiods (14–15 hours) seem to be more favourable. However, capsule formation, which occurs after 30 days is not affected by daylengths varying between 12–15 hours.

In another experiment groups of plants raised at 8-hour photoperiod, were exposed to 2, 4 and 6 long days (15 hours) at cotyledonary leaf (1 week old plants), 6–8 leaf (3 weeks) and 12–14 leaf (5 weeks) stage. After long-day treatment the plants were returned to short-day (8 hours) condition and after 30 days the number of flowers formed were counted.

Like few other plants reported[1-3] *Anagallis arvensis* also shows juvenile photoperiodicity (Fig. 2). However, maximum sensitivity appears to be attained when the plants are about 3 weeks old and 3–4 pairs of fully expanded leaves are present. At this stage the time required for induction of floral bud formation is distinctly less than that at the cotyledonary or 12–14 leaf stage. At least six inductive cycles are required to produce approximately the same number of flowers at any stage of vegetative development studied presently. However, a comparison of data of Figs. 1 and 2 will indicate that repeated inductive cycles produce more number of flowers than the limited number shown in Fig. 2.

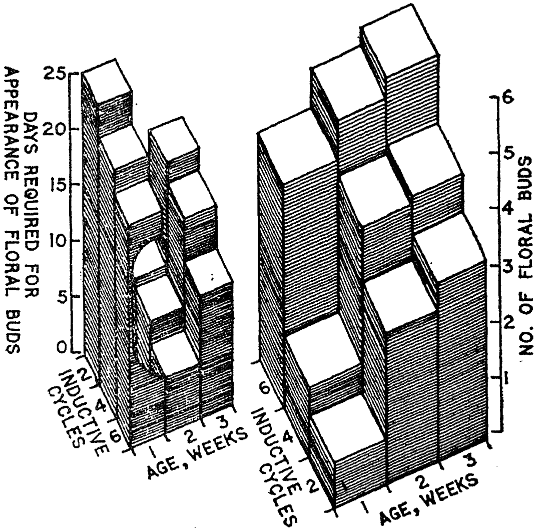

FIG. 2. Effect of different numbers of inductive cycles given to plants at various vegetative developmental stages upon the time required for appearance of first visible floral bud (left), and on the total number of floral buds produced (right).

The author is grateful to Prof. R. Misra and Dr. K. C. Misra for constant guidance. This research has been financed in part by the P.L. 480 grant of U.S.D.A.

Department of Botany, K. P. SINGH.
Banaras Hindu University,
Varanasi-5, *June* 26, 1968.

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THE EFFECT OF MATURITY UPON FATTY ACID COMPOSITION IN THE OIL OF GROUNDNUT (*ARACHIS HYPOGAEA* L.) SEEDS

THE indeterminate fruiting habit in groundnuts causes the appearance of fruits of different stages of maturity.[1,2] It was found in many previous works that the oil content in the seeds increases gradually up to a maximum with the progress of maturity. Chemical composition of the seed is closely related with the morphological symptoms of the developing fruit.[6] It was assumed that possible differences in nutrient supply to basal and apical seed, which might be more favorable to the basal ones, may also cause differences in oil content observed.[4,5] The effect of seed maturity upon fatty acid composition of the neutral lipids in Virginia Bunch Improved variety analyzed by gas-chromatography is shown in Table I.

TABLE I

Differences in fatty acid composition in mature and immature seeds (calculated as a percentage of the fatty acids in the neutral lipids)

Fatty acid		Stage of maturity		S.E.
		Mature	Immature	
Palmitic	..	11·6	10·5	±0·210
Oleic	..	48·8	45·6	±0·865
Linoleic	..	38·2	43·9	±0·705

It is evident from Table I, that there is a reciprocal relationship between the oleic and linoleic acid content in mature and immature seeds. The linoleic acid level in the oil of seeds is of practical importance, since it was proved that a highly significant negative relationship exists between linoleic acid level and keeping time (or storage) of the seeds.[3]

Div. of Industrial Crops, A. HAR-TZOOK.
The Volcani Inst. of
Agricultural Research,
Bet Dagan, Israel,
January 23, 1969.

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REVIEWS AND NOTICES OF BOOKS

Analytical Reaction Gas Chromatography. By **Viktor G. Berezkin.** (Translated from Russian. Translation Editor: L. S. Ettre.). (Plenum Publishing Corporation, 227, West 17th Street, New York, New York 10011, U.S.A.), 1968. Pp: x + 193. Price $ 12.50.

An exhaustive review of recent work in this new gas chromatographic technique, this volume includes theoretical concepts, experimental development, and practical applications. Different forms of apparatus are discussed from the standpoint of their use in specific types of analyses and with various types of detectors. This book covers in detail analysis of mixtures and impurities and elemental analysis, both quantitative and qualitative.

The main titles of the chapters contained in this book are: I. Main Directions in the Development of Analytical Reaction Gas Chromatography; II. Some Problems in the Theory of Analytical Reaction Gas Chromatography; III. Chromatography Systems in Analytical Reaction Gas Chromatography; IV. The Analysis of Complex Mixtures; V. Analysis of Impurities; VI. Analysis of Polymers and Other Nonvolatile Compounds; VII. Elemental Analysis; VIII. Qualitative Analysis and Change in Detector Sensitivity; and IX. Selective, Chemically-Active Sorbents in Gas Chromatography.

C. V. R.

Catalytic and Kinetic Waves in Polarography. By S. G. Mairanovskii. (Translated from Russian by Lela M. Fabuss. Translation Editor: Petr Zuman). (Plenum Publishing Corporation, 227, West 17th Street, New York, New York 10011, U.S.A.), 1968. Pp. xiv + 352. Price $ 19.50.

Dealing mainly with the polarographic investigation of fast protolytic reactions, this work, written by a leading scientist in his field, emphasizes the characteristics and relationships controlling the chemical reactions taking place at the electrode surface. The objectives of this important work, based mainly on data gathered at the N. D. Zelinskii Institute of Organic Chemistry of the Academy of Sciences of the USSR, are twofold. The first is to show examples and methods of investigations of electrode processes occurring at the dropping electrode complicated by chemical reactions taking place at the electrodes, and the second to demonstrate how the kinetic parameters of fast reactions in solution can be calculated on the basis of investigation of electrode processes.

The topics dealt with in this book are: Basic Principles of the Polarographic Method; Currents Limited by the Rate of Chemical Reaction; Adsorption on the Electrode and the Electrode Processes; Electrode Processes with Antecedent Protonation Reaction; The Effect of the Double-Layer Structure on Electrode Processes; Electrode Processes with Participation of Adsorbed Compounds; Mixed Volume—Surface Waves; The Effect of Dimerization of Electrode Products on Processes with Reversible Electrochemical Stage; Catalytic Hydrogen Evolution at the Dropping Mercury Electrode caused by Organic Catalysts; The Effect of Composition of Aqueous Organic Solvents on the Polarographic Behaviour of Organic Compounds; and The Effect of Antecedent Metal Ion Discharge on Polarographic Reduction Waves of Organic Compounds.

C. V. R.

Annual Review of Genetics (Vol. 2). Edited by H. L. Roman. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. vii + 456. Price $ 8.50 in U.S.A. and $ 9.00 elsewhere.

In planning the present volume, the Editors and the Editorial Committee adhered to the policy expressed in the preface of Volume 1. The topics are representative of the broad areas of Genetics, and supplement and extend the contents of the preceding volume.

The articles contained in this volume are: Herman Joseph Muller, by G. Pontecorvo; Regulation of Chromosome Function, by Ulrich Clever; Chromosomal and Subchromosomal Inactivation, by Mary Lyon; The Interchromosomal Control of Recombination, by John C. Lucchesi and David T. Suzuki; Genetic Effects of Radiation on Mammalian Populations, by Earl L. Green; Ciliate Genetics: Patterns and Programs of Gene Action, by D. L. Nanney; The Genetics of Cultured Mammalian Cells, by Robert S. Krooth, Gretchen A. Darlington, and Antonio A. Velazquez; Experimental Population Genetics, by Eliot B. Spiess; Genetics of Antibodies, by Leonard A. Herzenberg, Hugh O. McDevitt, and Leonore A. Herzenberg; Transduction Mechanisms, by Haruo Ozeki and Hideo Ikeda; Human Genetics: Structure of Population, by William J. Schull and Jean W. MacCluer; The Genetics of the Lambdoid Phages, by William F. Dove; Human Serum Protein Polymorphisms, by Kare Berg and Alexander G. Bearn; Synaptinemal Complex, by Montrose J. Moses; and Bee Genetics, by Walter C. Rothenbuhler Jovan M. Kulincevic and Warwick E. Kerr. C. V. R.

Organic Chemistry. (3rd Edition). By C. W. Wood, A. K. Holliday and R. J. S. Beer. (Butterworth and Co. Publishers Ltd., 88, Kingsway, London W.C. 2), 1968. Pp. 346. Price 25 *sh*.

This popular book on Organic Chemistry since its first publication in 1960 went through several reprints followed by a second edition with many reprints. The present book is the third edition in the production of which the third author has joined. Written to fulfil the requirements of the G. C. E. and Advanced and Scholarship examinations the book will also be useful to entrance university students taking to a degree course in chemistry or other majors.

The completely revised and rewritten third edition emphasises the reactions of organic chemistry in terms of simple concepts of structure and mechanism. Various aspects of electronic theory are discussed. There is also a revision in the examination questions at the end of each chapter, the old questions being replaced by newer ones. A. S. G.

Transactions of the Bose Research Institute (*Golden Jubilee Issue*). (Bose Institute, 93/1, Acharye Profulla Chandra Road, Calcutta 9), Pp. vi + 77–245. Price Rs. 15, $3, £1.

This issue (Vol. 30, Nos. 3 and 4) of the *Transactions* is a special number to mark the Golden Jubilee of the Institute (1917–1967). It contains seventeen articles contributed by well-known scientists belonging to different disciplines, and they cover a wide range of subjects. There are many text-figures and a total number of 18 plates. A. S. G.

Hand-Book of Methods of Tests for Cotton Fibres, Yarns and Fabrics. By V. Sundaram and R. L. N. Iyengar. (Published by Dr. V. Sundaram, Director, Cotton Technological Research Laboratory, Adenwala Road, Matunga, Bombay-19). Pp. 175. Price Rs. 10·00.

The Cotton Technological Laboratory, established in 1924, and now under the administrative control of the Indian Council of Agricultural Research, has carried out pioneer work in the standardisation and adoption of suitable testing techniques for cotton. The present monograph describes various testing techniques that have been standardized and are in vogue. The separate chapters are concerned with ginning tests, fibre tests, spinning tests, yarn tests, fabric tests, moisture tests, chemical tests, etc. The publication will be useful to students of textile technology and those concerned with cotton research in trade and industry. A. S. G.

Books Received

Commercial Vegetable Growing. By H. D. Tindall. (Oxford University Press, Mount Road, Madras-2), 1968. Pp. xi + 300. Price Rs. 27·00.

The Geological Society of America: Memoir No. 88—*Saline Deposits*, Pp. 701. Price $ 19; Memoir No. 101—*Abstracts for 1966, Special Papers*, Pp. 485, Price $ 7.50; Memoir No. 104—*Coastal Dunes of California*, Pp. xi + 131. Price $ 8.50. (The Geological Society of America, P.O. Box 1719, Boulder, Colorado 80302), 1968.

Encyclopedia of Library and Information Science (Vol. 1). Edited by A. Kent, H. Lancour. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1968. Pp. 676. Price: Non-subscription $ 45.00; Subscription $ 35.00.

Tin in Your Industry. By W. T. Dunne (Tin Publications Ltd., 7, High Road, London W. 4), 1968. Pp. 48. Price not given.

Applied Spectroscopy Reviews. Edited by E. C. Brame Jr. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1968. Pp. viii + 455. Price $ 16.50.

The Bond to Carbon (Vol. 1, Part II). Edited by A. G. Mac Diarmid. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1968. Pp. xiii + 261. Price $ 17.75.

1021-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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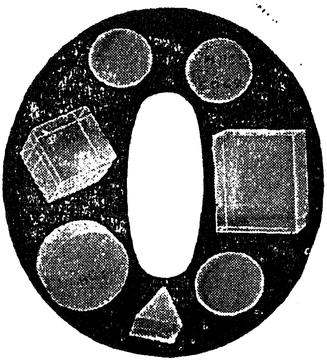

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FLORAL COLOURS AND THEIR ORIGINS*

Sir C. V. RAMAN

Abstract

A new orientation is given to the subject of floral colours by the author's discovery that these colours may be placed into two distinct spectral categories, which have been designated by him respectively as the spectrum of florachrome A and of florachrome B. Typical of these two categories are the colours of *Delphinium ajacis* (Larkspur) in the blue and pink varieties respectively, the former showing the spectrum of florachrome A and the latter that of florachrome B. As a general rule, all blue flowers exhibit the spectrum of florachrome A which consists of three distinct and clearly separated bands of absorption appearing respectively in the red at 630 mμ, in the yellow at 580 mμ and in the green at 540 mμ. The spectrum of florachrome B also consists of three distinct bands of absorption, but these now appear in the orange-yellow at 590 mμ, in the green at 545 mμ and in the blue-green at 505 mμ. Spectra exhibiting these features are reproduced with the paper. Their explanation is discussed and it is shown that they owe their origin to an electronic absorption frequency located at the first of the three bands combining with vibrational transitions, the oscillator being the CO group present in the structure of the florachrome.

1. Introduction

The colours which flowers exhibit when held in bright sunlight represent the physiological perception of the radiation which emerges from their petals after suffering diffusion and absorption within their substance. The spectral characters of the light emerging from the petals and the physiological characteristics of human vision which determine the sensation produced by the composite radiation have alike to be taken into consideration. Any discussion of floral colours which ignores either of these determining factors, would not only be futile but may also lead one to erroneous conclusions.

The processes of absorption and diffusion suffered by light in its passage through the petals and its emergence therefrom are determined by the nature and condition of the materials present within the living substance of the flower. It follows that no inference regarding these materials can be valid or sustainable unless it is based on their optical and spectroscopic behaviours observed *in vivo*. If one attempts to extract from the flowers the materials responsible for the observed colours, it is necessary to use processes which do not fundamentally alter their nature. In particular, if a solvent is used for the extraction, it should be such that it does not produce an observable change in the optical properties or spectroscopic behaviour of the pigment.

When one examines the voluminous literature in which the subject of floral colours and their origin has been dealt with, one fails to find any recognition of the fundamental considerations set forth in the two preceding paragraphs. The identification of the materials responsible for the colours of flowers as "anthocyanins" and the explanations put forward for the great differences in colour exhibited by various flowers are thereby rendered highly dubious. In treatises on plant biochemistry, the anthocyanins are placed in the general category of "flavonoids". The parent substance which gives the name to this group of organic compounds is flavone and it is a significant fact that this substance is itself a colourless solid which melts at 97°. How such a substance can be transformed into the brilliantly coloured floral pigments merely by hydroxylation and combination with glucose or other sugar residues is a mystery which one seeks in vain for an elucidation in the chemical literature.

From what has been stated above, it is evident that the origin of the vivid colours exhibited by many flowers *in vivo* has so far remained an unsolved problem. The present investigation addresses itself to finding an answer to the highly interesting questions arising in this field.

---

* This was the subject of the Presidential Address to the 34th Annual Meeting of the Indian Academy of Sciences at Ahmedabad on Sunday, the 22nd of December, 1968.

2. FLORACHROME A

A new orientation is given to the subject of floral colours by the author's discovery that the spectral character of the light emerging from the petals of flowers is related to the observable hue of the flowers in a highly characteristic fashion. We may illustrate this finding by a reference to some cases studied by him in earlier years.

The well-known avenue tree known botanically as *Jacaranda mimosifolia* bears numerous clusters of bluish-purple bell-shaped flowers. The climbing plant *Thunbergia grandiflora* bears large and widely expanded flowers of a pale blue colour. The well-known shrub *Plumbago capensis* commonly used as a hedge plant bears clusters of small flowers which are azure-blue in colour. Examination through a pocket spectroscope reveals that the spectra of the light diffused by or transmitted through the petals in all these three cases are very similar, *viz.*, three distinct absorption bands well-separated from each other, one in the red region of the spectrum at about 630 mμ, another in the yellow region at about 580 mμ and a third in the green at about 540 mμ. Holding two petals of the *Thunbergia* flowers together and viewing the light transmitted through them with the spectroscope, all the three bands are very clearly seen, the bands in the red and in the yellow being very conspicuous and the band in the green much less so. The absorption by the flowers of *Plumbago capensis* is very weak, but the bands are well seen when a bunch of the flowers held together is viewed through the spectroscope. It should be mentioned that in none of the three cases is there any sensible weakening of the blue region of the spectrum.

We next consider three other cases in which the observed colours are more vivid. The first is of the tree *Solanum grandiflorum* which bears large flowers of a deep bluish-mauve colour. The next is the climbing plant *Clitoria ternata* (also known as the Butterfly Pea), which bears curiously shaped flowers which in one variety are deep blue in colour. The third case is that of the plant *Meynia erecta*, which bears funnel-shaped open-mouthed flowers. One variety of this shrub bears flowers which are a deep purplish-violet in hue. In all three cases, the absorption spectrum as viewed either by the transmitted or by diffused light exhibits three bands which appear respectively in the red, yellow and green regions of the spectrum. As is to be expected, the bands as seen with these flowers are more conspicuous than with the less vividly coloured flowers mentioned earlier.

It is unnecessary here to list more flowers displaying absorption spectra of the same kind, as they will be referred to later on. The examples cited are sufficient to justify the statement that the origin of the colours displayed is the presence in the flowers of a material with the stated spectral behaviour, *viz.*, three distinct absorption bands appearing respectively in the red, yellow and green regions of the spectrum. The three bands in its absorption spectrum are very clearly seen in Fig 1. Figure 1 *a* is the comparison spectrum of white light, while Fig. 1 *b* and Fig. 1 *c* recorded with different exposures are absorption spectra of an aqueous extract from the blue larkspur obtained in the manner later to be explained.

3. FLORACHROME B

The author's study of floral colours in other cases led to the discovery of another material which will be here designated as florachrome B which also exhibits three absorption bands, but these now appear respectively in the orange-yellow, green and blue-green regions of the spectrum. A particularly fine example of a flower exhibiting the three absorption bands in the stated region is the terrestrial orchid known botanically as *Spathoglottis plicta*. This orchid is very hardy and may be grown in pots like any other plant. It has elongated leaves and bears a great many racemes of flowers on erect spikes of considerable length. Being always in bloom, it is available at all times for observation of the very striking nature of the absorption spectra of the flowers. Each flower has five petals which are well-separated from each other, so that any one of them can be viewed without being detached from the rest. The colour of the petals is a vivid purplish-red and the absorption spectrum which gives rise to this colour is most conveniently studied by holding the flower in a strong light and viewing the selected petal through a pocket spectroscope held not too far away from it. The spectrum of the light diffused by the petal as thus observed exhibits *a nearly complete extinction of the orange-yellow region of the spectrum from 580 mμ to 600 mμ*. Another dark band is conspicuous between 540 mμ and 550 mμ, but it is not one of complete absorption. A third and comparatively faint absorption is visible between 500 mμ and 510 mμ. The red region

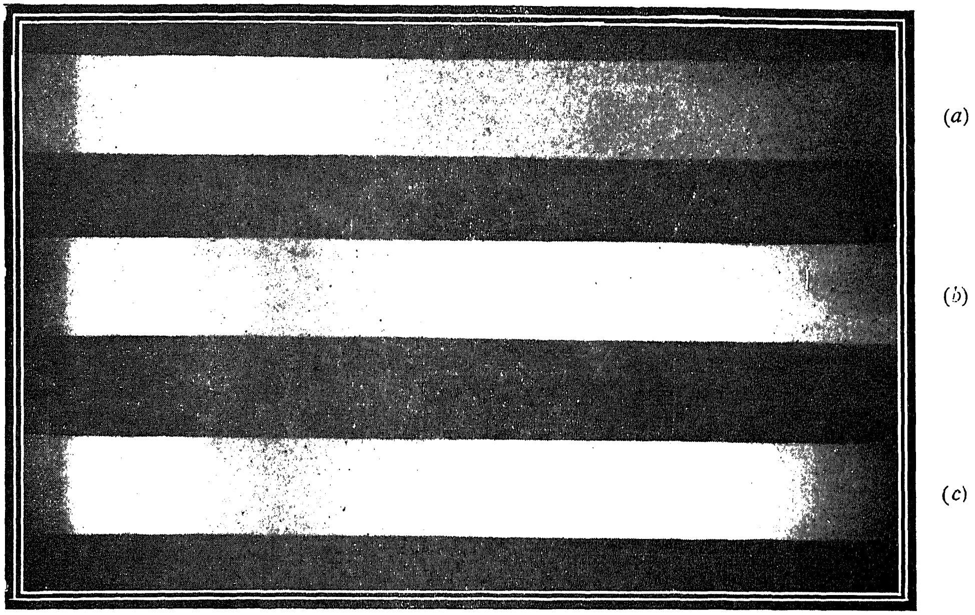

FIG. 1. Absorption Spectra of Florachrome A.

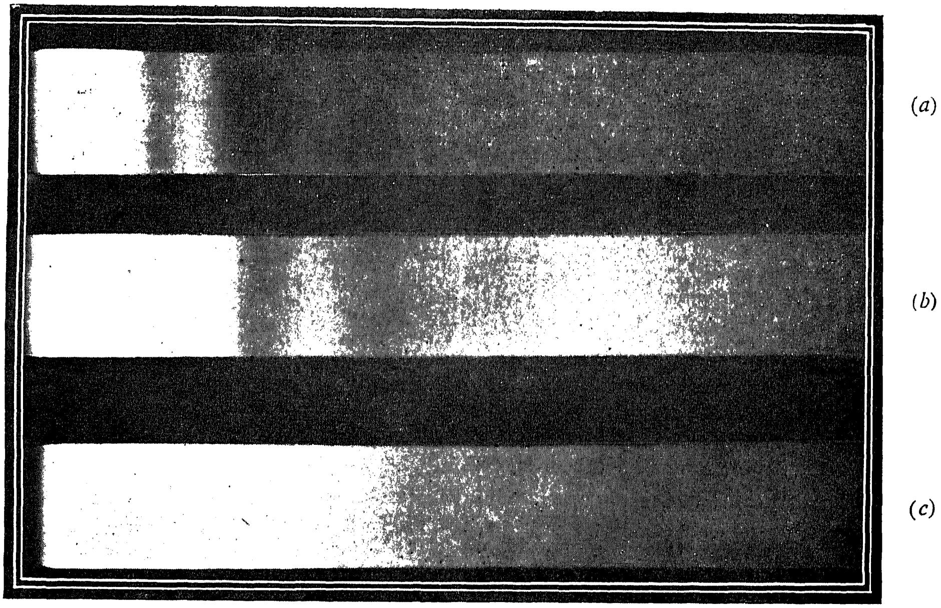

FIG 2. Absorption Spectra of Florachrome B.

of the spectrum is seen with full strength. There is also no observable weakening of the blue region of the spectrum. Figure 2 reproduces the absorption spectra of a petal of *Spathoglottis plicta* recorded by placing the petal before the slit of a wavelength spectrometer. Figure 2 *a* and 2 *b* reproduce the spectra thus obtained with different exposures, while Fig. 2 *c* is the comparison spectrum of white light.

4. Some Colourful Garden Plants

The role played by the two florachromes in the production of the observed colours of flowers is very well illustrated by the case of *larkspur*. This is a favourite garden plant belonging to the botanical category *Ranunculaceœ*. Gardening books describe the larkspur as "a very showy annual, freely producing spikes of beautiful flowers, available in blue, lilac, purple, white and pink shades." The plant grows well at Bangalore and the flowers which are available fall into two clearly defined groups. One of the groups may be described as exhibiting blues and bluish-purples of various shades. The other group exhibits a pink colour ranging from a bright to a very light shade of that hue. Spectroscopic examination of the light diffused by the petals of the first group reveals that they owe their colour to florachrome A. Likewise, it is found that the flowers of the other group owe their colour to florachrome B. In either case, the deeper the colour, the more pronounced are the absorption bands, thereby indicating that the intensity of the perceived colour is determined by the quantity of florachrome present in the petals.

The spectra of florachrome A and florachrome B are vividly exhibited by the flowers of *Cineraria* which is classed botanically as belonging to the *Compositœ*. Gardening treatises describe the *Cineraria* as "beautiful pot plants which are showy with their large luxuriant leaves surmounted by immense panicles of magnificent flowers of most brilliant colours; the blooms last for quite a long time, nearly a month." The colours are observed to fall into two groups, one group ranging between a light blue and a dark violet, and another from a light to a deep purplish-red. Spectroscopic examination reveals that the flowers of the first group exhibit the spectrum of florachrome A and those of the second exhibit the spectrum of florachrome B. As is to be expected in view of the brilliance of the colours, the absorption bands are highly pronounced and are indeed very striking.

Delphinium is another garden plant which is of great beauty. Its flowers appear arranged along spikes, the colours ranging from a delicate blue to a dark purple or violet. In every case, the petals exhibit the spectrum of florachrome A, the strength of the absorption bands increasing with the depth of the colour exhibited by the flower.

Iris germonica, also known as Flag Iris, has sword-like leaves and bears flowers on erect stalks. It is a hardy and vigorous plant and the flowers which are curiously constructed have gorgeous colours, one of the most attractive varieties being that in which flowers are purplish-blue. The petals of the flower are very thin, and hence it is desirable to hold two of them together and examine the light transmitted by them to observe the absorption bands. Here again, we notice three well-separated bands and recognise the spectrum as that of florachrome A.

Petrea volubilis is classed botanically amongst *Verbenacœ*. It is a climbing plant which requires a support on which it can spread out. It bears purple star-like flowers in large elegant wreath-like sprays. Racemes of flowers crowd the plant covering it with a mass of purple-blue colour. Holding a bunch of the flowers in sunlight and comparing the spectrum of the light diffused by their petals and by a sheet of white card held below, it becomes evident that there is practically complete extinction of the yellow part of the spectrum, besides a noticeable weakening of the red region. The blue sector, on the other hand, shows up quite strongly. It is evident that the bluish-purple colour exhibited by the sprays of *Petrea volubilis* is due to florachrome A present in the petals.

Asters belong to the botanical group known as the *Compositœ*. They bear very showy flowers, exhibiting numerous petals arranged around a common centre. The varieties which are grown extensively at Bangalore as a commercial proposition for export to other parts of India exhibit brilliant colours. These flowers are readily available for study. They show a great range of hues. A considerable proportion exhibit colours ranging from a light pink to a deep red or crimson. There is another group of flowers whose colours range from a light bluish-purple to a deep colour which may be termed as violet. Holding the flowers in sunlight and viewing them through a pocket spectroscope, their optical behaviour may be compared with that of a white card below, and several remarkable facts come to notice. Particularly interesting is that there is no noticeable difference between the two groups of flowers in respect of the blue sector of the spectrum which is conspicuous in the spectrum of the diffused light in both cases. But the two groups differ markedly in other respects. With the blue flowers, the red sector of the spectrum is much weakened and it also shows an indication of being divided into two by an absorption band running through it. A dark absorption band also covers the yellow sector while the green remains fairly bright. On the other hand, the flowers which range in colour from pink to crimson show the red sector of the spectrum in full strength. But the yellow and green sectors are both much weakened. These features are readily understood when it is recognised that the colours of the blue asters are ascribable to florachrome A and those of the red asters to florachrome B.

5. THE ISOLATION OF THE FLORAL PIGMENTS

Treatment by immersion either in dilute acids or in dilute alkalies has a destructive effect on the florachromes. This becomes evident when, for example, the blue petal of delphinium is immersed in dilute hydrochloric acid. The petal changes to a bright red colour, and examination through a pocket spectroscope reveals that the discrete absorption bands due to florachrome A have disappeared. The discoloured petal shows a spectrum in which the green sector is nearly extinguished and the yellow is weakened, while the red sector appears in full strength. Immersion of a petal of delphinium in dilute ammonia results in its changing colour from blue to a greenish-blue. The discrete bands disappear and the spectral regions of red and yellow appear with greatly reduced intensities, while the green continues to be in full strength. The purplish-red petals of *Spathoglottis plicta* which exhibit the absorption spectrum of florachrome B change colour to an orange-red on immersion in dilute HCl. The discrete absorption bands disappear and the green sector of the spectrum is nearly extinguished, while the yellow and red sectors appear with normal strength. The petal of the same orchid when treated with dilute ammonia changes colour from a purplish-red to a greenish-blue. The discrete absorption bands disappear and while the green of the spectrum retains its full strength in the transmitted light, the red and yellow sectors become extremely weak. Examples of this kind may be indefinitely multiplied to show that the effect of acids and alkalies on flower petals is fundamentally to alter their spectroscopic behaviour.

In view of the facts stated above, it is scarcely possible to accept the view that the anthocyanins prepared by the methods usually adopted by organic chemists are the pigments responsible for the colours exhibited by flowers *in vivo*. It is, of course, of great interest to isolate these pigments from the flowers so that their behaviour can be studied *in vitro*. But for these purposes, as has already been stated in the introduction, it is necessary to adopt methods which do not fundamentally alter the optical properties and spectroscopic behaviour of the pigments. Such methods are indeed available.

In many cases, it is possible to obtain an extract of the floral pigment merely by grinding a few moist petals to a fine paste in an agate mortar and then adding a little water and filtering the product through a loose plug of cotton-wool into the observation cell. The aqueous solution of the floral pigment thus obtained is often of considerable strength and may have to be diluted to obtain the desired degree of transparency. Using a longer or shorter cell to hold the extract also enables the strength of the transmitted light to be controlled.

A second and generally useful method is to place a sufficient quantity of the flower petals in a flask and to pour in some acetone to cover the petals. Vigorous shaking results in the pigment being extracted by the acetone and a solution of adequate strength being obtained which can be transferred to an observation cell. In those cases where the extraction by the acetone proceeds too slowly, it can be speeded up by warming the flask, or if necessary by heating it till the acetone begins to boil.

The extraction of the floral pigment by the method first described is evidently to be preferred as it is a purely physical process which would not result in any alteration of the structure and properties of the florachrome. Indeed, the aqueous solutions obtained by that process show a spectroscopic behaviour similar to that of the petals themselves. It should be mentioned however that the extract may include some colloidal material which has passed through the filtering plug of cotton-wool and diminishes its transparency to light.

The extraction of the pigment with the aid of acetone is generally both quick and convenient, and if the petals used are quite clean, the solution obtained is free from colloidal matter and exhibits the maximum transparency. The method has the advantage that by adjusting the quantity of material put in and the volume of acetone made use of, it is possible to obtain extracts which show the absorption bands in satisfactory strength, *viz.*, more petals and less acetone for weakly pigmented flowers, and fewer petals and more acetone for strongly pigmented ones. The spectroscopic behaviour of the pigment can then be observed in more satisfactory conditions than with the petals themselves. It should be mentioned, however, that the acetone extracts do not always reproduce exactly the spectral behaviour of the petals. It is noticed that the relative intensities of the absorption bands are altered, and their positions may also exhibit observable shifts.

6. VISUAL PERCEPTION OF COLOUR

We proceed to consider how the observed colours of the flowers are related to the spectral characteristics of the florachromes. A few remarks are necessary here regarding the composition of white light and the visual effects produced by the different parts of its spectrum. The relative luminosities of the various regions of the spectrum depend to a great extent on the absolute level of brightness at which the observations are made. At the fairly high levels with which we are here concerned, the most luminous part of the spectrum is the yellow sector, the limits of which may be indicated as from 560 mμ to 600 mμ. Its great influence on our visual perceptions is readily demonstrated by viewing a brilliantly illuminated area of white light through a filter of glass doped with neodymium oxide which cuts out the spectral region between 570 mμ and 600 mμ completely, but has very little effect on the rest of the spectrum. An enormous reduction of visual brightness is found to result from holding such a filter before the eye. It is a consequence of this characteristic of our visual sensations that the exclusion of the yellow sector in the spectrum by absorption is necessary for the other parts of the spectrum to manifest themselves strongly in the perception of colour. Indeed, extensive studies demonstrate that no object can appear brilliantly green or blue or red unless the yellow of the spectrum has been much weakened or totally excluded from appearing by absorption.

In view of what has been stated, the role of the florachromes in the production of visible colour is readily understood. Both florachrome A and florachrome B exercise a strong absorption on the yellow sector of the spectrum. Further, florachrome A also exercises a noteworthy absorption in the red sector of the spectrum, while florachrome B does not exhibit such absorption, but on the other hand has an absorption of significant strength in the green sector of the spectrum. A large reduction in the strength of the yellow sector and the enfeebling of the red and green sectors would enable the blue sector to manifest itself and by masking the rest of the spectrum to become the dominant sensation. *Per contra*, a large reduction in the strength of the yellow and green sectors would enable the red sector to mask the rest of the spectrum and become the dominant colour. For such effects to be manifested to the maximum extent respectively by florachrome A and by florachrome B, it is necessary that they should be present in the petals in adequate quantities.

That the absorption of light appearing in the yellow sector of the spectrum plays a highly important role in the perception of floral colour becomes evident when a flower is viewed through a neodymium glass filter. In all cases where the absorption of the yellow by the flower itself is incomplete, the introduction of the filter before the observer's eye completes the process and the result is an enrichment of the observed colour. For example, a pink larkspur viewed through the filter appears red. Such enrichment of the observed colour becomes a spectacular phenomenon when a tree enveloped by a mass of its flowers is viewed through the neodymium filter. Two examples of such trees may be mentioned here. One of them is *Milletia ovalifolia,* which in the flowering season bears great masses of tiny flowers of a lilac colour. They make the tree a conspicuous object even from a distance. The interposition of the filter results in a very striking intensification of the massed colour of the flower-laden branches which then appear of a reddish-purple colour. Another case is that of *Tabebuia guayacan* which is one of the loveliest of ornamental trees, bearing lilac-coloured flowers in the form of bunches or bouquets. Seen through the filter, these flowers turn to a rich red hue. Similar effects are exhibited by all flowers in which florachrome B functions but is not present in sufficient quantity to produce its maximum effect. Likewise, in all cases where florachrome A functions but the resulting colour is not very intense, the introduction of the filter produces a readily observable effect.

7. THE SPECTRA OF THE FLORACHROMES

It may be stated as a general rule that flowers which exhibit a blue colour contain florachrome A which is responsible for that colour being perceived. The more intense the colour, the greater is the quantity of the florachrome present, as may be demonstrated by the methods of extraction described above. In such cases, also, the three bands of absorption in the spectrum which are characteristic of florachrome A are conspicuously visible in the light diffused by the petals. Their positions can be approximately determined by observation through a direct vision spectroscope provided with a wavelength scale. A few such measurements are listed below :

Blue larkspur :	630 mμ,	580 mμ,	540 mμ
Delphinium :	630 mμ,	580 mμ,	540 mμ
Solanum grandiflorum :	630 mμ,	580 mμ,	540 mμ
Meynia erecta :	630 mμ,	580 mμ,	540 mμ

It will be noticed that the positions of the bands in the four cases listed are not observably different, and this is clear evidence that we are concerned with a material with specific properties appearing in flowers of totally different origin. In all four cases, the first band appearing in the red is the most conspicuous, while *per contra* the third band appearing in the green is weak and diffuse. These observations suggest that the band of the greatest wavelength represents the principal absorption of the material and that the other two bands arise from combinations of the principal electronic frequency with vibrational transitions. The differences in the wave-number of the successive bands are about the same and may be put as 1325. This may be regarded as the vibration frequency of the florachrome A.

As has already been stated, the complete spectrum of florachrome B is shown with admirable strength and sharpness by the terrestrial orchid *Spathoglottis plicta.* It is also shown vividly by several orchids of a purple colour and sundry other plants which have come under observation by the author. The bands of florachrome B are shown with special intensity by the flowers of *Cineraria* which display a purplish-red colour. The first two of the three bands can also be recognised in the spectrum of the pink larkspurs. They are as noted below :

Spathoglottis plicta :	590 mμ,	545 mμ,	505 mμ
Cineraria (purplish-red) :	600 mμ,	550 mμ,	510 mμ
Larkspur (pink) :	590 mμ,	545 mμ,	—

As in the case of florachrome A, the first band in florachrome B which here appears in the orange-yellow region of the spectrum is the most conspicuous, while, *per contra,* the third band appearing in the green-blue region is weak and diffuse. The same suggestions as those made above for florachrome A can also be put forward regarding the relationships between the three bands exhibited by florachrome B. The differences in the wave-number of the successive bands are about the same and may be put as 1425, which is the vibration frequency of florachrome B.

Since the absorption bands of florachrome B appear in the yellow and green sectors of the spectrum, these sectors appear with much reduced intensity, and as already mentioned, the result is that the red sector of the spectrum becomes dominant and determines the observed colour of the flower. The quantity of the florachrome B present determines the strength, in other words, the degree of saturation of that colour. This is well-illustrated by the case of *Spathoglottis plicta,* the commonest variety of which bears flowers which are of a vivid purplish-red colour. There is another variety of the same plant, the flowers of which are of a deep purplish-crimson colour. Spectroscopic examination of these flowers shows the same absorption bands but intensified in strength, so much so that the green and yellow are almost completely extinguished. It should be noted that neither variety of *Spathoglottis plicta* shows any observable weakening of the blue sector of the spectrum. It is therefore not surprising that the colour of these flowers is not a pure red or crimson but exhibits a purplish hue.

Many flowers which appear pink or red or crimson show a strong absorption of light in the yellow and green parts of the spectrum. That such absorption determines the observed colour is evident from the fact that it is deeper in the varieties which exhibit the absorption most strongly. The three bands which characterise florachrome B are not usually seen as distinct and separate regions in the absorption spectra of the petals of such flowers. We are nevertheless justified in assuming that the florachrome is present and is responsible for the observed colour. Red or crimson-roses may be mentioned as an example of such a situation. Definite proof that we are concerned in such cases with florachrome B is forthcoming when the spectrum of white light transmitted through a column of the acetone extract of the floral pigment is examined. The presence of distinct bands of absorption in the yellow, green and green-blue regions of the spectrum then becomes evident to observation.

8. THE STRUCTURE OF THE FLORACHROMES

The configuration of the anthocyanin molecules envisaged by the organic chemists is based on a grouping of atoms similar to the aromatic hydrocarbon naphthalene joined by a single bond to another grouping similar to benzene. There is however a noteworthy difference, *viz.*, that instead of ten carbon atoms arranged round the periphery as in naphthalene, we have only nine carbon atoms and one of oxygen. Since oxygen is divalent, it is not possible to have a regular succession of alternating single and double bonds around the periphery as in naphthalene. This disturbance in the order characteristic of an aromatic molecule results in a profound modification of the structure and optical behaviour of the grouping. One of the four valences of carbon atom adjacent to an oxygen atom is engaged in the formation of what may be described as a pseudo-double bond between this carbon atom and the adjacent oxygen. This pseudo-bond is necessarily much weaker than the double bond appearing in a carboxyl group, and as a consequence, its characteristic absorption is thereby shifted and falls within the range of the visible spectrum. The observable consequence is the production of visible colour. The vibration frequency of the pseudo-double bond will also be less than for a carboxyl group which is 1800 in wave-numbers. Such lowering of the vibration frequency will manifest itself in a closer approach of the vibration bands to the characteristic electronic frequency. As the oxygen atom is located between two carbon atoms occupying different positions in the group, there are two distinct situations of the kind described above which are possible. These are shown separately in the accompanying diagram (Fig. 3). One of the two situations corresponds to florachrome A and the other to florachrome B. In the latter case, the pseudo-double bond lies closer to the centre of the group and therefore presumably results in a somewhat stronger binding,

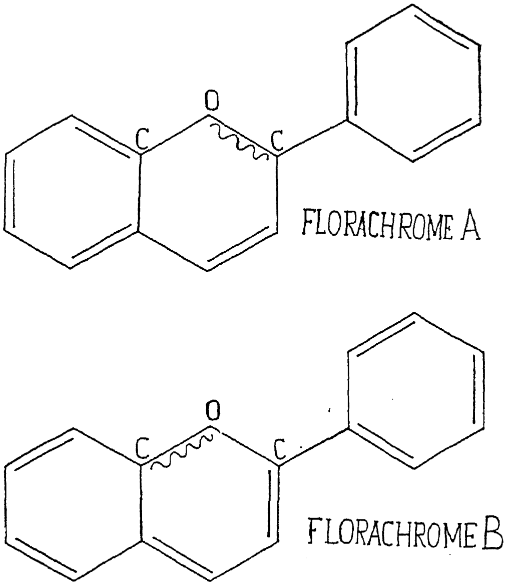

FIG. 3. Structure of the Florachromes.

LETTERS TO THE EDITOR

THE BAND SPECTRUM OF DIATOMIC BERYLLIUM IODIDE

THE characteristic band spectrum of the BeI molecule has been obtained in a high frequency discharge through a mixture of heated beryllium metal and iodine vapour. The discharge which appears bluish in colour, was photographed on a Fuess and Hilger three prism Glass Littrow spectrographs. The spectrum reveals the existence of a doublet system of red degraded bands in the region λ 4100–4500 A, attributable to the BeI molecule. This system appears to be the analogue of the well-known $^2\Pi$–$^2\Sigma$ systems of BeF, BeCl and BeBr.[1-3] The (0, 0) sub-bands of the doublet system occur with considerable intensity and are easily identified.

The band heads of the system could be attributed on the basis of a $^2\Pi$–$^2\Sigma$ transition with doublet splitting of 373 cm.$^{-1}$ for the upper state. The detailed classification of the band heads of the system designated as A–X are given in Table I. Figure 1 (*a*) shows the assignments of some of the bands of the system of BeI. The long-wavelength sub-band shown in Fig. 1 (*b*) reveals the presence of the band origin (indicated by an arrow) and unresolved R_1, Q_1, P_1 and $^OP_{12}$ branches.

TABLE I

Band head data of the A–X system of the BeI molecule

Wave-length (Å)	Wave-number (cm.$^{-1}$)	Intensity	Classification (v', v'')	Band head	$\nu_{obs.} - \nu_{calc.}$ (cm.$^{-1}$)
4135·49	24174·0	1	1, 0	R_1	..
4137·55	24162·1	1	2, 1	R_1	..
4139·69	24149·6	1	3. 2	R_1	..
4141·25	24140·5	2	1, 0	Q_1	+0·1
4143·43	24127·8	1	2, 1	Q_1	+0·5
4145·84	24113·8	1	3, 2	Q_1	+0·6
4170·22	23972·8	2	0, 0	$^SR_{21}$	..
4172·36	23960·5	2	1 1	$^SR_{21}$	..
4174·51	23948·2	2	2, 2	$^SR_{21}$	..
4180·51	23913·8	5	0, 0	R_2	..
4246·75	23540·8	10	0, 0	Q_1	0
4288·93	23309·3	2	0, 1	R_2	..
4291·36	23296·1	2	1, 2	R_2	..
4359·46	22932·2	4	0, 1	Q_1	−0·1
4477·62	22326·7	1	0, 2	Q_1	−0·3

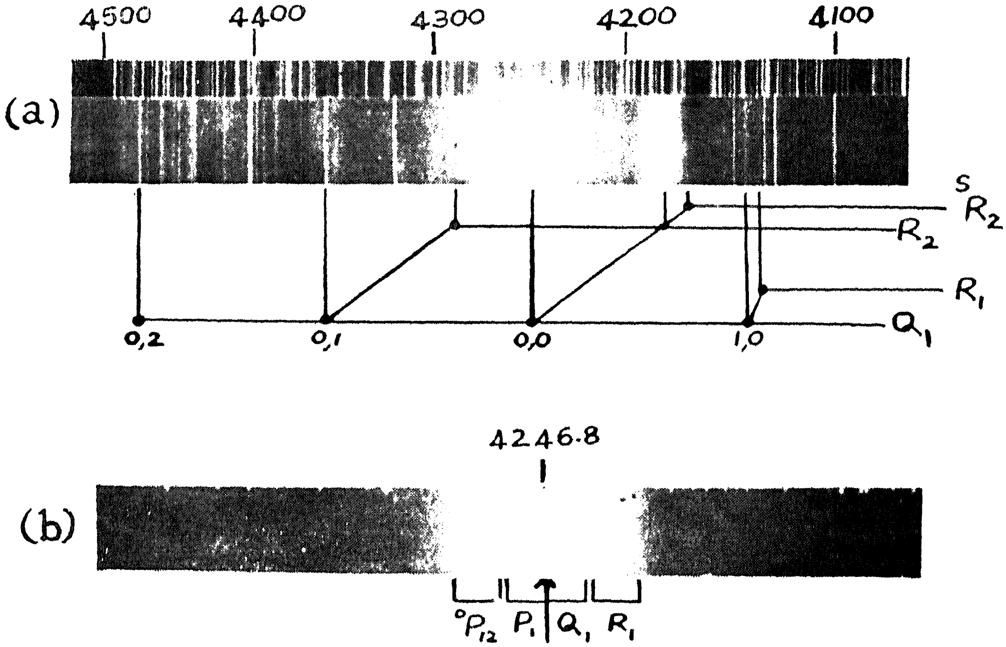

FIG. 1. (*a*) The A–X system of BeI (Fuess spectrogram), (*b*) The long-wavelength (0, 0) sub-band, showing four branches (Glass Littrow spectrogram).

The Q_1 heads of the system could be represented by the following vibrational quantum formula:

$$\nu_{Q_1} = 23544\cdot9 + 603\cdot8\ (v' + \tfrac{1}{2}) - 2\cdot1\ (v' + \tfrac{1}{2})^2 - 611\cdot7\ (v'' + \tfrac{1}{2}) + 1\cdot6\ (v'' + \tfrac{1}{2})^2.$$

The coupling constant (A = 373 K) and the vibrational constants derived from the analysis are entirely in keeping with those of BeF, BeCl and BeBr.

Spectroscopy Laboratory, P. SREENIVASA MURTY.
Dept. of Physics, P. TIRUVENGANNA RAO.
Andhra University,
Waltair, *November* 28, 1968.

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ADSORPTION OF NITROGEN AND ARGON ON IRON-KIESELGUHR AT LOW TEMPERATURES: EVIDENCE FOR ABSENCE OF CHEMISORPTION OF NITROGEN

KOKES[1] and several others have reported the chemisorption of nitrogen at its boiling point on the surface of transition metals like Fe, Co and Ni and have therefore suggested the use of inert gases like argon and krypton as adsorbates for calculating the surface areas of solids. It is also known that BET surface areas obtained by using nitrogen as the adsorbat are considerably higher (10-30%) than those obtained when argon is used as the adsorbate, the adsorbent being the same.[2] The absence of reports on the low temperature chemisorption of nitrogen on supported metal catalysts as well as the marked differences in the adsorption characteristics of unsupported and supported metal powders[3] prompted the present study.

Studies were carried out on samples of Iron-Kieselguhr prepared by the method of impregnation and reduced in a current of pure hydrogen at 450° C. The adsorption measurements were made on a conventional volumetric adsorption apparatus.[4] The quantity of adsorbed gas retained after adsorption at various temperatures (which is sometimes considered as the amount chemisorbed) was determined by using a Toepler pump instead of reading the difference between the adsorption and readsorption isotherms.[1]

The following series of experiments were performed on Fe-KgIV (19% Fe by weight).

1. Adsorption isotherm of nitrogen at − 191° C. after thorough evacuation at 450° C. to an ultimate pressure of 10^{-6} mm. Hg.
2. Exhaustive desorption of nitrogen at − 78° C. by means of a Toepler pump followed by collection and measurement of desorbed gas.
3. Readsorption isotherm of nitrogen at − 191° C.

A similar set of experiments was carried out with argon as the adsorbate to check whether the gas physically adsorbed at − 191° C. could be completely recovered by desorption at −78° C.

It was noticed that out of 118·91 ml. of nitrogen originally admitted at − 191° C., 118·90 ml. could be desorbed by means of the Toepler pump at − 78° C. Similarly 166·62 ml. of argon could be desorbed at − 78° C. out of 166·65 ml. admitted at − 191° C. The experimental points plotted in Fig. 1 show that the

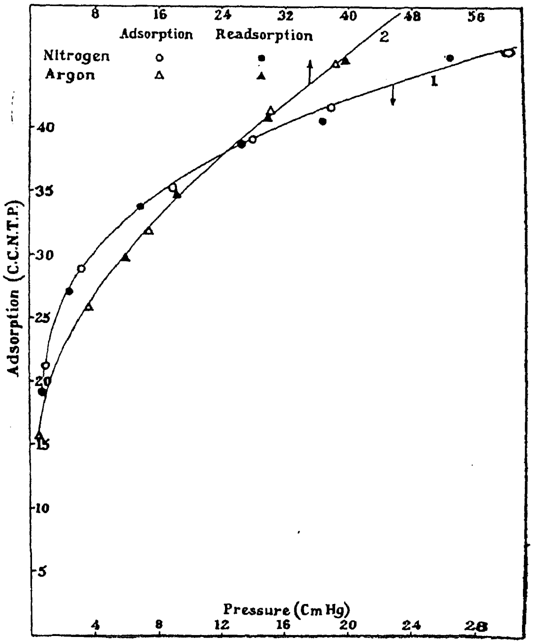


FIG. 1. Adsorption and readsorption isotherms of Argon and Nitrogen on Fe Kg IV, at −191° C.

adsorption and readsorption isotherms of nitrogen at — 191° C. coincide. A similar overlapping of adsorption and readsorption isotherms is also noticed with argon. The above experiments have given positive evidence for the absence of chemisorption of nitrogen (and argon) at low temperatures of the type reported by Kokes[1] and others.

It was, however, felt by the author that the interaction of nitrogen with the surface of a transition metal (like iron) could be stronger than that of argon at low temperatures, which may account for the chemisorption observed in certain cases. To confirm this point, the following set of experiments was performed on Fe–KgV (12% Fe by weight).

1. Adsorption isotherm of argon at — 191° C. on the clean surface.
2. Exhaustive desorption by means of a Toepler pump at — 191° C., the gas desorbed being collected and measured.
3. Evacuation at 450° C. to an ultimate pressure of 10^{-6} mm. Hg.
4. Adsorption isotherm of nitrogen at — 191° C. on the clean surface.
5. Exhaustive desorption by means of a Toepler pump at — 191° C., the gas desorbed being collected and measured.
6. Adsorption isotherm of argon on a surface containing nitrogen retained in step 5.

It was noticed that out of 8·80 ml. of argon originally adsorbed at — 191° C. (step 1), 0·78 ml. is retained after desorption. Similarly out of 5·29 ml. of nitrogen adsorbed at — 191° C. (step 4) 1·21 ml. is retained after desorption with the Toepler pump at the same temperature. This shows that the binding between nitrogen and iron kieselguhr is stronger than the binding between argon and the same surface.

It is noticed from the isotherms for the adsorption of argon plotted in Fig. 2, that the adsorption of argon is suppressed by 1·9 ml. due to the presorption of 1·2 ml. of nitrogen. To test whether a part of nitrogen is chemisorbed, the BET equation was applied to the data on the adsorption of argon at — 191° C. on the clean surface as also on the surface containing presorbed nitrogen (similar application of BET equation has been suggested by McIver and Tobin[5]). The BET plots are shown in Fig. 3. The BET area corresponding to the suppressed isotherm of argon was 10·04 m², while the area occupied by 1·2 ml. of nitrogen (assuming the cross-sectional area of the adsorbed nitrogen molecule to be 16·4 Å²) was 5·36 m². The sum of the areas occupied by the adsorbed nitrogen and argon is therefore 15·40 m². The BET area corresponding to the isotherm of argon on the clean surface was 15·76 m². The difference between the surface area determined on the clean surface and on the contaminated surface is practically within the limits of experimental error. If there was chemisorption of nitrogen on iron-kieselguhr, the surface area calculated by the additive method would have been more than that determined directly on the clean surface.

FIG. 2. Adsorption af Argon on Fe-Kg V at −191°C.

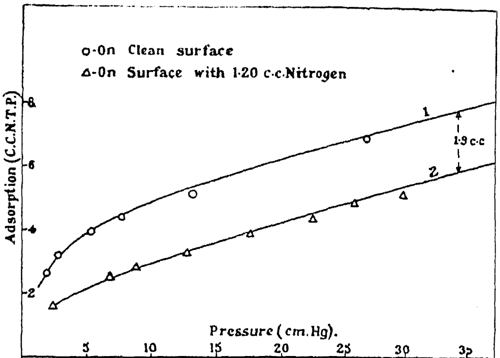
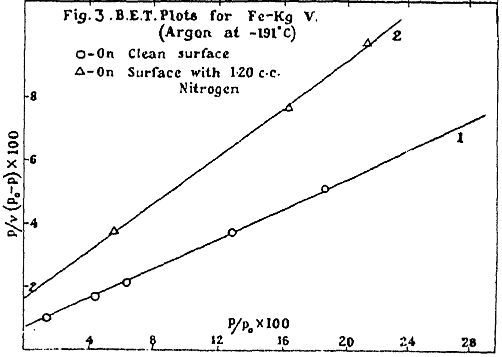


Fig. 3. B.E.T. Plots for Fe-Kg V. (Argon at -191°C)



The above set of experiments have not only shown that the weak nitrogen chemisorption observed by earlier workers[1,6] is true with certain systems, but have also given evidence for the stronger physical adsorption of nitrogen in comparison to that of argon. If the strength of adsorbent-adsorbate interaction can be assumed to be a function of the structure of the adsorbate (as a molecule or atom) and the nature of the adsorbent surface, one should then expect different values for the cross-sectional areas of the adsorbed molecules for each type of adsorbent-adsorbate pair. It has been shown[2] that the physical adsorption forces operating between nitrogen (and argon) become stronger, as the adsorbents are considered in the order : indifferent substances (like kiselguhr), metal oxides, non-transition metals and transition metals. It may also be possible that the "weak nitrogen chemisorption" reported by earlier workers is actually "strong physical adsorption".

The author expresses his gratitude to Prof. M. R. A. Rao, Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore, for his guidance during the course of this work.

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OXIDATION OF METHYLDITHIOBIURET WITH POTASSIUM FERRICYANIDE IN ALKALINE MEDIUM

POTASSIUM ferricyanide has been used for the oxidimetric determination of many organic as well as inorganic substances[1] in neutral or alkaline medium. The reagent belongs to the group of oxidants in which the active species is a complex-abstracting ion, $Fe(CN)_6^{3-} + e \rightarrow Fe(CN)_6^{4-}$. Although the oxidation potential of the couple in alkaline medium is only 0·4–0·5 *v vs.* N.H.E.,[2] it acts as a powerful oxidising agent by virtue of the reduced oxidation potential of the system containing the reductants in alkaline medium. The reaction could be catalysed by osmium tetroxide[3] or promoted by the addition of zinc (through the formation of insoluble zinc potassium ferrocyanide). Oxidation by potassium ferricyanide offers various advantages such as high purity of primary standard grade,[4] high equivalent weight, extreme stability and applicability in alkaline medium, etc. Like a great majohity of oxidants ferricyanide may be used for direct titration or may be added in excess and back titrated. Earlier observations reported the oxidation of thiourea and thiocyanate by alkaline ferricyanide.[5,6]

In the present study, methyldithiobiuret has been oxidised quantitatively by the addition of excess ferricyanide and a few drops of osmium tetroxide as catalyst. The excess ferricyanide was then back titrated with standard arsenite solution and the end point was detected amperometrically.

EXPERIMENTAL

Reagents :

Potassium ferricyanide: Pure E. Merck's sample recrystallised several times, from water and dried at 100° C. Iodometric titration against standard thiosulphate showed it to be 99·9% pure and it was subsequently used as a direct standard. Osmium tetroxide : 1 g. of Osmium tetroxide in 200 ml. of 0·1 N H_2SO_4.

Sodium arsenite: E. Merck's (pro-analyse) arsenious oxide dissolved in minimum quantity of sodium hydroxide and neutralised. The strength was further checked against iodate.

Methyldithiobiuret: 0·1492 g. of pure recrystallised sample dissolved in 100 ml. of water.

Procedure: An aliquot of methyldithiobiuret solution was taken in a beaker and its alkali concentration was maintained at 7%. A known excess of ferricyanide and two drops of osmium tetroxide were added and the contents were kept aside for 15 minutes to ensure complete oxidation. Excess ferricyanide was then back titrated with standard arsenite solution. For the detection of end point a simple "Dead stop end point" unit as suggested by Foulk and Bawden[7] was used. At an applied potential of +0·1 *v vs.* S.C.E., the cathodic current of ferridyanide decreased upto the end point and then remained steady with excess arsenite. The volume of arsenite required for unreacted ferricyanide was determined graphically. A blank titration was run simultaneously. From these observations the amount of ferricyanide consumed during the oxidation and the molar equivalent of oxidant required per mole of methyldithiobiuret was calculated. The results of a set of experiments with different amount of methyldithiobiuret is presented in Table I.

TABLE I

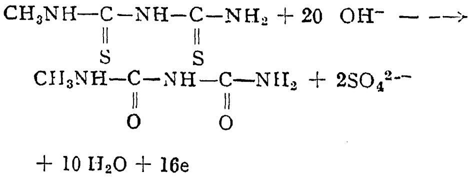
Methyldithiobiuret concentration—0·01 M
Potassium ferricyanide concentration—0·10 M
Overall alkali concentration—7%

Methyldithiobiuret taken (ml.)	Ferricyanide consumed (ml)	Ferricyanide equivalents per mole of methyldithiobiuret
0·5	0·805	16·10
1·0	1·605	16·05
1·5	2·385	15·90
2·0	3·190	15·95
2·5	4·005	16·02
3·0	4·805	16·02

Results in Table I show that 16 equivalents of ferricyanide are required for 1 mole of methyldithiobiuret. Since the reduction of ferricyanide involves only one electron the mechanism of the total oxidation process may be represented as follows:

The two half reactions involved are:

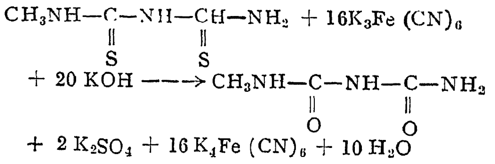
(1)



$$\mathrm{CH_3NH-\underset{\underset{S}{\|}}{C}-NH-\underset{\underset{S}{\|}}{C}-NH_2 + 20\ OH^- \dashrightarrow CH_3NH-\underset{\underset{O}{\|}}{C}-NH-\underset{\underset{O}{\|}}{C}-NH_2 + 2SO_4^{2-} + 10\,H_2O + 16e}$$

(2) $16\,\mathrm{Fe(CN)_6^{3-}} + 16\mathrm{e} \longrightarrow 16\,\mathrm{Fe(CN)_6^{4-}}$

Combining (1) and (2) we get:



$$\mathrm{CH_3NH-\underset{\underset{S}{\|}}{C}-NH-\underset{\underset{S}{\|}}{CH}-NH_2 + 16K_3Fe(CN)_6 + 20\,KOH \longrightarrow CH_3NH-\underset{\underset{O}{\|}}{C}-NH-\underset{\underset{O}{\|}}{C}-NH_2 + 2\,K_2SO_4 + 16\,K_4Fe(CN)_6 + 10\,H_2O}$$

This suggests that methyldithiobiuret is quantitatively oxidised to methylbiuret and sulphate ion by potassium ferricyanide in alkaline medium. The mechanism is in accord with that proposed for the oxidation of thiourea[5] and thiocyanate.[6]

Sincere thanks of the authors are due to Prof. G. B. Singh for facilities and to the University Grants Commission for the award of a fellowship to one of them (R. K. N.).

Dept. of Chemistry, G. S DESHMUKH.
Banaras Hindu University, R. K. NANDI.
Varanasi-5, *December* 6, 1968.

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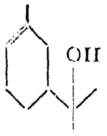
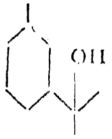
ON THE STRUCTURE OF *m*-MENTHENOLS CONSTITUTING SYLVETERPINEOL

FROM sylvestrene dihydrochloride, by the action of 2% aq. KOH, Wallach[1] obtained an unsaturated, optically active, tertiary alcohol, $C_{10}H_{17}OH$, which was designated as sylveterpineol. Upon oxidation of this alcohol with dilute $KMnO_4$, Haworth, Perkin and Wallach[2] obtained the following products: (*i*) a thick syrupy glycerol, $C_{10}H_{17}(OH)_3$, b.p. 165°/11 mm., which very reluctantly crystallised to a solid, m.p. 105°; (*ii*) δ-lactone of ϵ-keto-γ-hydroxyisopropylheptoic acid and (*iii*) 2-acetyl-1-methyl-Δ'-cyclopentene. Formation of the last two products suggested that sylveterpineol, in all probability, is a mixture of Δ^6-*m*-menthen-8-ol (I) and Δ'-*m*-menthen-8-ol (II). These alcohols have been synthesised;[3-5] but this has not clarified our knowledge regarding their structures.



I



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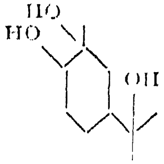
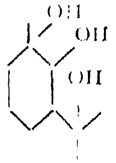


III



IV

More recently, the technique of extracting and purifying tertiary alcohols through *p*-nitrobenzoyl esters was employed by Chabudzinski[6] to resolve the components of sylveterpineol. The *p*-nitrobenzoates obtained, m.p. 98° and

66°, when saponified, were reported to yield alcohols of structures I and II respectively. In arriving at structure I, the only feeble evidence quoted is a cross melting point of the *p*-nitrobenzoate of m.p. 98° with that derived from naturally occurring sylveterpineol; without any experimental backing the naturally occurring sylveterpineol is assigned structure I.[7] On the other hand, absolutely no proof is available for attributing structure II to the isomeric alcohol.

We are engaged in a comprehensive investigation on the chemistry of the alcohols constituting sylveterpineol and wish to report some of the preliminary results of a new approach to the structural elucidation of one of the constituents, now shown to be Δ^6-*m*-menthen-8-ol.

Reaction of sylvestrene dihydrochloride with 2% aq. KOH at 75° for 5 hr. afforded, besides hydrocarbons and sylveterpins, an alcohol fraction which after a twofold distillation displayed the following characteristics: b.p. 90–92°/5 mm.; $(\alpha)^{25}_{D}$ + 46·70 (CHCl$_3$); d^{25}_{25} 0·9310, n^{30}_{D} 1·4782. Analysis—Calculated for $C_{10}H_{17}OH$; C = 77·87%; H = 11·76%; Found: C = 78·29%, H = 11·63%. Gas-liquid and thin layer chromatography of the alcohol cut disclosed that it is constituted of two components.

Following essentially the directions of Chabudzinski,[6] the above oil was esterified with *p*-nitrobenzoyl chloride in pyridine medium and the two crops of esters were repeatedly recrystallised, m.p. 66° and 98°.

The ester of m.p. 98° was examined in detail: Empirical formula $C_{17}H_{21}O_4N$; $(\alpha)^{20}_{D}$ + 54·85 (CHCl$_3$); I.R. band in KBr at 1710 cm.$^{-1}$ (ester $>C=O$). Because of long range allylic coupling, the only tentative conclusion that could be deduced from the n.m.r. spectrum of the ester is that it is likely to be derived from I.

Hydrolysis of the ester adopting the procedure of Chabudzinski[6] afforded a homogeneous (*glc*, single peak; *tlc*, single spot) alcohol conforming to the formula $C_{10}H_{17}OH$; yield, 80% theoretical; b.p. 91°/5 mm.; $(\alpha)^{25}_{D}$ + 102·80 (CHCl$_3$), d^{23}_{23} 0·9380, n^{25}_{D} 1·4807; I.R. bands (film); 1667 cm.$^{-1}$ and 820 cm.$^{-1}$ ($>C=CH-$), 1149 cm.$^{-1}$ and 3671 cm.$^{-1}$ ($\geqslant C-OH$) and at 1379 cm.$^{-1}$ [$>C(CH_3)_2$]. The structure of this alcohol was established as Δ^6-*m*-menthen-8-ol through n.m.r. spectrum. The irradiation of the methyl resonance in structure I gave the expected triplet with broadened lines as against a doublet with further fine splitting if alternate structure II were the case.

Additional support for the assigned structure of the alcohol resides in the n.m.r. spectrum of the triol III derived from the above alcohol. Oxidation of the alcohol with 2·5% aq. KMnO$_4$, furnished the desired compound as a sticky mass. This was repeatedly regenerated from a solution in ethyl acetate by addition of light petroleum (b.p. 40–60°) until homogeneous in thin layer chromatography. Formula $C_{10}H_{17}(OH)_3$ corroborated by analytical data; b.p. 167–168°/11 mm., $(\alpha)^{20}_{D}$ + 23·66 (CHCl$_3$).

According to structure III, the only proton at a carbon with a hydroxyl group is coupled to two adjacent protons; this should result in a quartet in the n.m.r. spectrum. Actually in the spectrum a quartet is seen, which is probably the X-part of an ABX system. This proves structure III for the triol and hence the sylveterpineol which furnishes the *p*-nitrobenzoyl derivative with m.p. 98° must possess structure I.

The full interpretation of the N.M.R. spectra referred to above requires the use of different solvents and this is in progress; the structure of the second alcoholic constituent of sylveterpineol is also being investigated.

Our thanks are due to Dr. A. Melera and Dr. A. Dieffenbacher, Varian AG for n.m.r. analysis, Dr. Sukh Dev and Dr. C. N. Pillai for *glc* runs and Dr. D. K. Banerjee and Dr. G. S. Sidhu for i.r. spectra. This work is supported by a Junior Research Fellowship to one of us (K. G. K.) from the Council of Scientific and Industrial Research, New Delhi.

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DETERMINATION OF CINNAMIC ACID WITH CHLORAMINE-T

THE possibility of using chloramine-T for the determination of unsaturated organic compounds suggests itself. Our findings with a typical unsaturated acid—cinnamic acid—are reported in this communication.

Preliminary experiments showed that slightly more than two equivalents of oxidant per mole of cinnamic acid are consumed during the oxidation and that, therefore, the results are not analytically useful. A modified procedure was therefore developed, in which an excess of potassium bromide was taken along with the chloramine-T. In this case, the real oxidant would be bromine, produced *in situ*, from potassium bromide and chloramine-T. The addition of potassium bromide during titrations of substances with chloramine-T and with dichloramine-T has been found to be advantageous by earlier workers.[1,2]

Known volumes (50 ml.) of standard decinormal chloramine-T solution (prepared and standardised as described earlier[3,4]) were taken in 500 ml. stoppered conical flasks. To each were added 5 N. sulphuric acid (25 ml.) and 10% KBr solution (20 ml.). Measured aliquots of standard cinnamic acid solution were now introduced and the contents were shaken. After 5 minutes, 25 ml. of 10% KI solution was added and the liberated iodine was titrated with standard thiosulphate. Blanks were run concurrently; no blank corrections were found necessary. Typical results are given in Table I.

TABLE I

Oxidation of cinnamic acid with chloramine-T in presence of KBr

Expt. No.	Millimoles of cinnamic acid taken	Time allowed for oxidation (minutes)	Milliequivalents of oxidant consumed	Equivalents of oxidant consumed per mole of cinnamic acid
1	0·2525	5	0·5070	2·01
2	0·4679	5	0·9414	2·01
3	0·5049	5	1·006	1·99
4	0·5049	5	1·010	2·00
5	0·4679	30	0·9632	2·06
6	0·4679	45	0·9632	2·06

It may be seen from Table I that two equivalents of the oxidant are consumed per mole of cinnamic acid. This corresponds to dibromination of cinnamic acid as represented by the following equations.

$$\mathrm{RNCl^- Na^+ + 2H^+ + 2e^- \longrightarrow RNH_2 + Na^+ + Cl^-} \quad (1)$$

$$\mathrm{2Br^- \longrightarrow Br_2 + 2e^-} \quad (2)$$

$$\mathrm{C_6H_5 - CH = CH - COOH + Br_2 \longrightarrow C_6H_5 - CHBr - CHBr - COOH} \quad (3)$$

It should be pointed out that, in order that the chloramine-T—bromide reaction (producing bromine) is quantitative, the pH of the solution must be less than five.[4]

Univ. Dept. of Chemistry,   B. GOPALAKRISHNAN NAIR.
University of Kerala,   C. G. RAMACHANDRAN NAIR.
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GENETICS AND BIOCHEMISTRY OF A RIBOFLAVINE REQUIRING MUTANT OF *ASPERGILLUS NIDULANS*

ABSTRACT

A riboflavine-deficient mutant of *Aspergillus nidulans* was isolated by ultra-violet irradiation. The mutant gene was located by mitotic and meiotic analysis. This mutant designated as *ribo 8* was found to be non-allelic to the riboflavineless mutants *ribo 1* to *ribo 7* isolated earlier. Apart from the purines, alloxan, a pyrimidine, showed riboflavine activity in this mutant. The results suggest that 1, 2-dimethyl 4-amino 5, (D'ribityl) amino benzene and alloxan are involved in the biosynthesis of riboflavine.

IN our attempts to screen a number of mutant strains of *Aspergillus nidulans*, obtained by ultra-violet irradiation of spores from a parent strain Y, *bi 1* (spore colour green and requiring biotin for growth), we obtained a mutant requiring riboflavine which has been designated as Y *bi 1 ribo 8*. Allelic tests by complementation studies, indicated that this mutant is non-allelic with the riboflavineless mutants *ribo 1*, *ribo 2*, *ribo 5*, and *ribo 6*, isolated earlier and reported themselves to be non-allelic.[1] Mitotic analysis by *para*-fluoro phenyl alanine induced, haploidisation of diploids,[2] indicated that the mutation site of *ribo 8* is in the first chromosome. Attempts were made to find out the recombination frequency between *ribo 8* and two other markers *an 1* (aneurine) and *bi 1* (biotin) which have been located earlier in the first chromosome.[3] From a cross between two strains, Y, *ribo 8* and *an 1, bi 1, w 3 ; pyro 4 ; s 3,* the recombination frequencies between *an 1* and *ribo 8* was between 30 and 35% and *bi 1* and *ribo 8* was between 40 and 45% indicating that the gene *ribo 8,* is not linked with either *an 1* or *bi 1.*

The mutant *ribo 8* was found to be temperature independent and the growth-promoting effect of some riboflavine-like substances or alleged precursors of riboflavine[4] are presented in Table I.

although *y, ribo 8* (with yellow conidiospores) could utilise adenine, adenosine and alloxan, instead of riboflavine for growth, white and green spored *ribo 8* strains could not. Strains of other riboflavineless mutants with yellow spore colour were observed to show some growth, in the absence of riboflavine.[4] From the table it is seen that 1, 2 dimethyl 4-amino, 5, (D'ribityl) amino benzene has no action on the growth of the organism. However, its analogues 1, 2 dimethyl-4-5-diamino benzene and 0-diamino benzene competitively inhibit the growth of the riboflavineless mutant at sub-optimum levels of growth, indicating that 1, 2 dimethyl 4 amino 5-(D'-ribityl)-amino benzene may be a precursor of riboflavine as suggested earlier[1] in *A. nidulans.* Woolley *et al.*[6,7] have observed inhibition of riboflavine synthesis in bacteria by analogues of dimethyl diamino benzene. Results in Table I indicate that all the riboflavine analogues with the basic isoalloxazine ring structure inhibit the growth of the mutant. Further the pteridine, 6, 7-dimethyl lumazine and 4, ribityl amino 5-amino uracil

TABLE I

Effect of compounds related to riboflavine structurally or involved in its biosynthesis added in the absence or along with riboflavine at sub-optimum level 1 mg. of the test-substance added per 50 ml. of agar media per dish in plate test ; and 0·1 ml. of solution of the test substance (1 mg./ml.) in Auxanographic Test Growth was observed after 48 hours

	Compounds tested	Strains tested without riboflavine added			Strains tested with Riboflavine at sub-optimum level		
		y, ribo 8	*w 3, ribo 8*	*y, ribo 8*	*y, ribo 8*	*w 3, ribo 8*	*y, ribo 8*
1	Minimal Medium alone ..	+	− −	−	+	−	−
2	MM+flavin mono-nucleotide ..	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +
3	MM+riboflavin ..	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +
4	MM+Alloxan ..	+ + +	+	+	+ + + +	+ + + +	+ + + +
5	MM+Adenine ..	+ + +	−	−	+ + + +	+ + + +	+ + + +
6	MM+adenosine ..	+ + +	−	−	+ + + +	+ + + +	+ + + +
7	MM+xanthine ..	+ +	+ +	+ +	+ + + +	+ + + +	+ + + +
8	MM+histidine ..	+ +	−	− −	+ + + +	+ + + +	+ + + +
9	MM+lyxoflavin ..	−	−	−	+ +	+	+
10	MM+ribonolactone ..	−	−	−	+ + +	+ + + +	+ + + +
11	MM+leucopterine ..	−	−	−	+ + + +	+ + + +	+ + + +
12	MM+6-chloro, 9-(1−D sorbityl) isoalloxazine	−	−	−	+	+ +	+
13	MM+6, 7-dimethyl 0-(B hydroxy) -ethyl isoalloxazine	+	−	−	+ +	+	+
14	MM+1, 2-dimethyl 4, 5-diamino benzene ..	−	−	−	+ + +	+ + +	+ + + +
15	MM+1, 2-dimethyl, 4-amino 5-(D' ribityl) amino benzene	+	−	−	+ + + +	+ + + +	+ + + +
16	MM+6, 7-dimethyl 8-ribityl lumazine ..	+ + +	+ + +	+ + +	+ + + +	+ + + +	+ + + +
17	MM+4-ribitylamino 5-amino uracil ..	+ +	+ + +	+ +	+ + + +	+ + + +	+ + + +
18	MM+6-methyl 7, hydroxy 8-ribityllumazine	+	−	−	+ + + +	+ + + +	+ + + +
19	MM+0-diamino benzene ..	+	−	+ +	+ + +	+ + + +	+ + + +
20	MM+ribopyranose tetra acetate ..	−	−	−	+ + + +	+ + + +	+ + + +

+ + + + indicates 100% growth; + + + indicates 75% growth; + + indicates 50% growth; + indicates less than 10% growth ; —no growth.

The involvement of purines in riboflavine biosynthesis has been reported earlier by indirect observation.[5] The first direct observation on the utilisation of a pyrimidine precursor is the growth-promoting activity of alloxan for the mutant *y, ribo 8* presented in Table I. Neither the nucleoside adenosine nor the sugar derivatives show any characteristic riboflavine activity for the mutant. It is interesting to note that are found to have partial growth-promoting activity on the strains tested. These compounds have been reported to be present in cultures of flavinogenic micro-organisms[8,9] in plants[10] and in riboflavineless mutant of *A. nidulans.*[11] The inhibition produced by leucopterin, a pteridine derivative, adds weight to the participation of a pteridine compound in the biosynthesis.

Univ. Biochem. Laboratories, Madras-25,
C. S. SHYAMALA DEVI.
RADHA SHANMUGASUNDARAM.
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November 20, 1968.

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CALCIUM CARBONATE IN THE SEDIMENTS OF THE EASTERN PART OF THE BAY OF BENGAL

THE Geological problems relating to the conditions of formation of limestones have greatly stimulated the study of calcium carbonate of marine sediments, because most of the limestones were formed under marine environmental conditions. This paper elucidates the distribution of calcium carbonate in the bottom sediments of the eastern part (Lat. 7° 40′–20° 28′; Long. 92° 20′–97° 59′) of the Bay of Bengal. Even though considerable information is available on the different aspects of the bottom sediments of the western part of the Bay, little is known about the sediments of the eastern part. Sewell (1925) recorded a few (four) observations of calcium carbonate as determined by Alcock. 24 samples from different marine facies covering the eastern part have been collected during a cruise on "Anton Brunn", a U.S. Oceanographic ship, under the leadership of E.C. La Fond as a part of International Indian Ocean Expedition in 1963. Most of the sediments were collected by dredge and snapper. Calcium carbonate is estimated by Hutchinson and Maclennan's method (1947).

RESULTS AND DISCUSSION

There is wide variation of calcium carbonate from 2% to 58% in the region under present study. In the discussion emphasis is placed upon the percentage of $CaCO_3$ rather than upon the type of calcareous material. One of the most striking features in the distribution of calcium carbonate is the very low value of 8·2% in the northern part and high values of 45% in the southern part on an average. The line of demarcation of these two areas roughly coincides with the northern extremity of Andaman Islands. The possible explanation for the lowered percentage of calcium carbonate in the northern area is the discharge of Indian and Burmese rivers (Brahmaputra and Irrawadi) emptying their silt-laden waters into this area. As pointed out by Sewell (1925) the presence of extensive Globigerina ooze in the southern region explains the high percentage of carbonate. This is also due to lack of river contribution of terrigenous material in this region. The second factor controlling the distribution of calcium carbonate is the production of calcareous planktonic forms, which is high in low latitudes when compared to high latitudes (Sverdrup *et al.*, 1955).

Considering the variation of $CaCO_3$ content as a function of depth, at first there is an increase in percentage with depth followed by a fall and again a rise (Table I). This type of variation with depth generally agrees with the pattern given by Alcock (*Vide* Sewell, 1925). The decrease of non-calcareous terrigenous deposits as one proceeds into deeper waters away from the land accounts for the initial increase of carbonate content. The two factors namely temperature and pressure, increase the solubility of the calcareous shells while sinking through deeper waters. This explains the low carbonate content of sediments of the deeper parts (Correns, 1938).

TABLE I

Sl. No.	Depth in Fathoms	No. of samples	Percentage of $CaCO_3$
1	0– 25	5	6·4
2	25– 50	10	33·2
3	50–100	2	35·2
4	100–200	5	43·5
5	550	1	9
6	1360	1	21

Special mention may be made about a sample (Lat. 12° 23′, Long. 93° 20′) collected at a depth of 36 fathoms with 98% carbonate content, which is identified as white coral limestone. Oldham (1885) has recorded a large series of raised coral beaches all along the eastern side of Andamans.

Conclusions.—The authors arrive at the following conclusions based on the analytical data obtained and also from the fact that the marine sediments tend to be uniform over large areas.

1. There are two distinct types of sediments covering this part of the Bay of Bengal, one being the calcareous sediments in the southern region with high carbonate content and the second being the terrigenous sediments of the northern region with low carbonate content.

2. There is a gradual decrease in calcium carbonate content towards higher latitudes (Fig. 1).

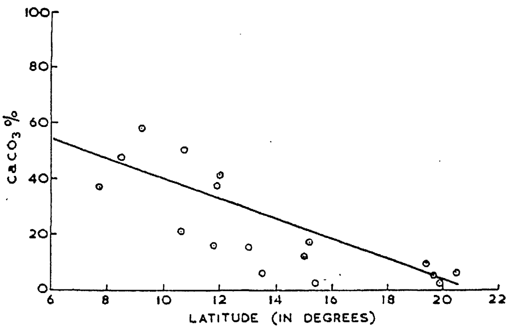

FIG. 1. Distribution of calcium carbonate content with Latitude.

3. No systematic relation exists between the depth and calcium carbonate content of the sediments. But it is noted that the carbonate content of the deeper parts is generally low.

4. Binocular microscopic observation of sediment samples shows that carbonate content is mostly due to shell fragments, corals and calcareous foraminifera.

We acknowledge our grateful thanks to Dr. E. C. La Fond of U.S. Naval Undersea Center, San Diego, California, for giving the samples utilised in the present study.

Dept. of Geology, N. V. N. DURGA PRASAD RAO.
Andhra Univ., M. POORNACHANDRA RAO.
Waltair, *November* 20, 1968.

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ON A NEW SPECIES OF *PHILODICUS* LOEW (ASILIDAE, DIPTERA) FROM INDIA

THE genus *Philodicus* was erected by Loew in 1848. Ricardo (1921) and Broomley (1935 and 1938) described several species from the Indian region. Ratanlal (1960) catalogued 13 species of the genus from the Indian and adjoining areas. Blasdale (1957) revising the genus from the Ethiopian region brought together all the misplaced species of *Philodicus* from *Alcimus*. While working on a collection of Indian Asilids, I came across a unique female specimen from Puri, which is described here as new to science.

Philodicus jagannathi SP. NOV.

Female: Head black; vibrissæ white; facials long and white, frontals white, post-orbitals pale yellow; palpi black with long white fine hairs; Antennæ black, segment 1 black with pale hairs, apex of segment 2 reddish-brown with short pale hairs, segment 3 swollen, black, style long, black at base and pale ochraceous at apex.

Dorsum black, pubescent with short hairs; mesonotum posteriorly with long white bristles; slopes of lateral swellings of metanotum bare; scutellum black with a dense growth of long white hairs and bristles at disc and border; pleura black with patches of long white hairs.

Legs black and reddish-yellow; femora black with long whitish pubescens all over and weak white hairs beneath; hind femora with three antero-dorsal and five ventral bristles; tibiæ rufous basally and black apically covered all over with ochraceous hair; tarsi with small hairs all over besides very long bristles.

Wings pale yellow, veins yellowish-red, R_1 and $R_2 + 3$ meeting before wing margin, cell R_1 closed with a short petiole, R_5 and M_1 united at tip and ending in a short petiole; stem of halter pale yellow, knob reddish-brown.

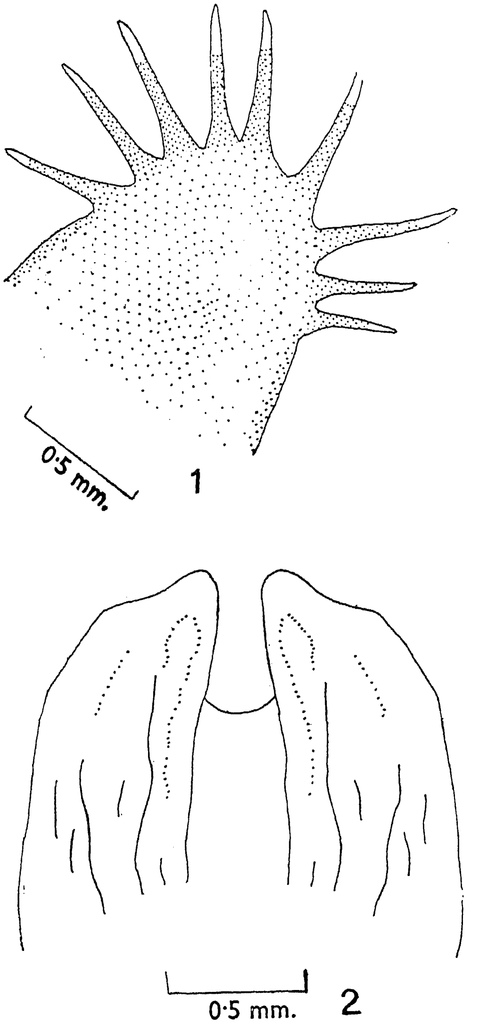
Abdomen black with whitish pubescens; basal tergite with long white hairs at sides; ovipositor black with a terminal circlet of 9 large spines, the latter black at base and ochraceous at tips (Fig. 1) 8th sternite long (Fig. 2).

Male Unknown.

Length: ♀, 23 mm. of wing 15 mm.

Holotype ♀, India, Puri (Orissa), 10-4-1966, coll. Syd Radinovsky.

The Type will be deposited in Zoological Survey of India, Calcutta.



FIGS. 1-2. *Philodicus jagannathi* sp. nov. Fig. 1. Apex of ovipositor, dorsal view; Fig. 2. 8th sternite, ventral view.

Philodicus jagannathi sp. nov. resembles *P. grandissimus* Ricardo closely but can be easily distinguished from it as well as from other species of the genus by the possession of a circlet of 9 large spines at the apex of ovipositor, chætotaxy of hind femora and by the union of R_5 and M_1.

I thank Dr. A. P. Kapur, Director, and Shri K. S. Pradhan for facilities, Shri B S. Lamba and Dr. A. N. T. Joseph for the encouragement and Dr. Syd Radinovsky of All India Institute of Hygiene and Public Health, Calcutta, for placing the material at my disposal.

Zoological Survey of India, K. RAMCHANDRA RAO.*
Calcutta, *September* 9, 1968.

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* Present Address: Z. S. I., Western Regional Station, Poona.

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RELATION BETWEEN INVIGORATION AND ROOTING OF GUAVA (*PSIDIUM GUAJAVA* L.) STEM CUTTINGS

THE differential rooting behaviour of juvenile and non-juvenile stem cuttings has been reported earlier.[1,2] The easy or difficult to root nature of these cuttings has been correlated to the mechanically restricting influence of phlœm sclerenchyma.[3,4] But such a relationship could not be found in olive, pear and cherry cuttings by Sachs *et al.*[5] Biochemical differences of these two types of tissues have been studied by Hess.[6]

The differential rooting behaviour of the non-juvenile and the invigorated greenwood cuttings in guava (*Psidium guajava* L.) was studied by the authors. The invigorated cuttings were obtained from shoots of an old graft after beheading it 2–3 m. from the ground.

The anatomical study of these shoots has revealed the presence of phlœm sclerenchyma in both types of shoots of the same age. In the non-juvenile shoots, the density of these cells was found to be more than in the invigorated shoots, but in both, the cell groups had wide gaps in between. The poor rooting behaviour of the non-juvenile cuttings could not therefore be attributed to the density of the sclerenchyma cells, because the root initials in the cuttings could come out through the gaps between the sclerenchyma groups.

The auxin activity of the extracts of these two types of shoots by the *Avena* coleoptile straight growth test[7] has shown slightly higher growth-promoting activity in the invigorated tissue extract than in the non-juvenile tissue extract (Fig. 1), but in the latter a growth inhibiting zone was observed at R_f 0·2–0·3, whereas no such inhibition was noticed in the former. Auxin requirement can be supplemented by external application, but it did not initiate sufficient rooting in non-juvenile cuttings. They showed only 13·3% rooting with 5000 ppm IBA in comparison to 90% in cuttings obtained from invigorated shoots.

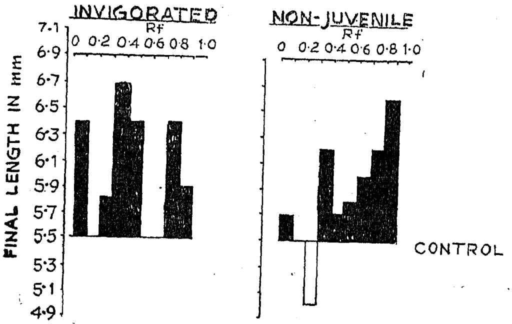

FIG. 1. Histograms showing Biological activity of Chromatograms of Invigorated and Non-Juvenile Tissue Extracts of Guava Stem Cuttings. Extract Chromatographed in Isopropanol Ammonia-Water (8 : 1 : 1) ; Bioassay *Avena* Coleoptiles 4 mm. long, taken 3 mm. below tip.

When the extracts of these two types of tissues were assayed for rooting co-factors by mung bean rooting test[6] it was observed that in the case of invigorated tissue extract there were three distinct active root promoting zones at R_f 0·1, 0·3–0·4 and 0·6–0·8, whereas in the non-juvenile tissue extract such an activity was considerably low and was restricted only to R_f 0·5–0·8 with a maximum activity at R_f 0·6–0·7 (Fig. 2). At all other R_f values the root inhibition was observed in the case of non-juvenile tissue extract only but not in the invigorated tissue extract. These extracts exhibited their maximum activity only when assayed in combination with IAA. Without IAA such an activity was considerably reduced. It suggests that certain root promoting substances present in the extracts act synergistically with the added IAA. In the case of non-juvenile tissue extract, the absence of such root promoting substances to act along with the added IAA, might have caused inhibition of rooting at certain R_f values.

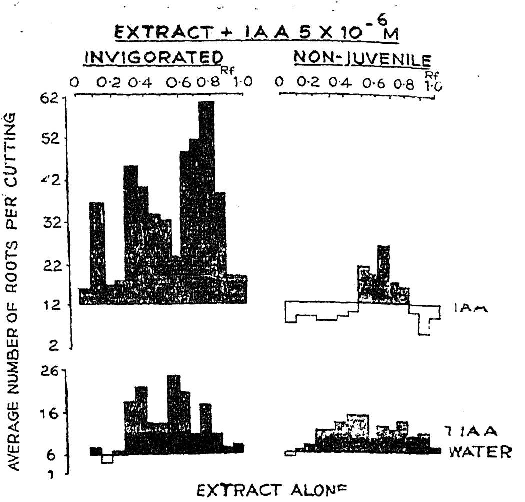

FIG. 2. Effect of Extracts of Invigorated and Non-Juvenile Guava Cuttings upon Root Initiation in the Mung Bean. Solvent System Isopropanol : Water (8:2 V/V).

The differential rooting behaviour of these two types of shoots can thus be attributed to the presence of variable amount of certain rooting substances. The invigorated shoots, obtained after beheading, behaved similar to juvenile cuttings as far as the rooting activity is concerned. Similar phenomenon was also observed in case of mango (*Mangifera indica* L.).[8] The rooting co-factors obtained by Hess[6] from the juvenile *Hedera* cuttings appeared to be somewhat similar to that obtained in the present study. The rooting co-factors 1 and 2 were very similar in their activity at R_f values observed.

This technique of rooting of cuttings from invigorated shoots may have a wide application in horticulture and forestry for other trees, where it is difficult to make clonal propagation.

Division of Horticulture, K. R. BHANDARY.
Indian Agricultural S. K. MUKHERJEE.
Research Institute,
New Delhi (India), *November* 5, 1968.

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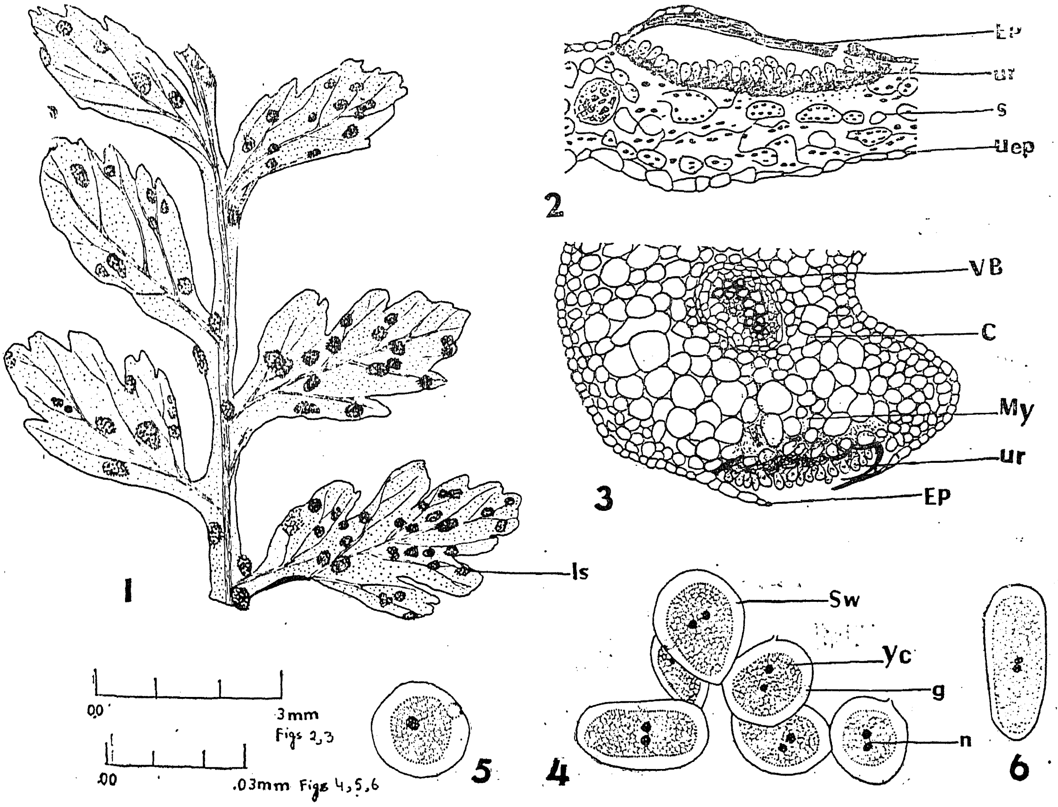
HYALOPSORA POLYPODII ON *ATHYRIUM FILIX-FOEMINA* FROM KASHMIR, INDIA

In October 1967 we visited Kashmir and collected many ferns along with some plants of *Athyrium filix-fœmina* which were infected by *Hyalopsora polypodii* (Diet.) Magn. The plants occur on the right bank of the Liddar River, near Pahalgam.



FIGS. 1–6. Fig. 1. Part of infected leaves and rachis (× ca 1½). *Ls*, lesions. Fig. 2. Part of leaf in Transverse section. Fig. 3. Part of rachis in Transverse section showing uredospores in group. Fig. 4. Uredospores of various shape and size. Fig. 5. Circular uredospore. Fig. 6. Elongated uredospore. *c*, cortex; *Ep*, epidermis; *g*, Germpore; *My*, Mycelium; *n*, Nuclei; *S*. Mesophyll tissue; *SW*, Spore Wall; *Uep*, Upper epidermis; *VB*, Vascular bundle; *Yc*, Yellow content of spore.

The material collected by us has no teliosori. Uredosori are present on leaves as well as on the rachis. Some of the infected plants collected by us are very young, they have few leaves, the rachis is thin and short, about 4 cm. long. Hand sections of the infected leaves and rachis were prepared. For the detailed study of uredospores squash mounts were also made. The rust fungus *Hyalopsora polypodii* (Diet.) Magn. reportedly occurs quite commonly on *Athyrium filix-fœmina* in Japan. About 30 years back Sydow (1938) reported *Hyalopsora polypodii* infecting *Cystopteris fragilis*, and since then, as far as the authors are aware, it has not been reported from this country again.

Description.—Lesions on leaves and rachis (Fig. 1) diffuse, variable in size, up to 0·5–1·0 mm. in diameter, somewhat yellowish, soon becoming dark yellow to brown, smaller ones coalescing to form large irregular pustules which cover the leaf partly or almost entirely. Hyphæ intercellular, not clearly distinguishable from the host tissue, usually not extending beyond the cortical region in case of the rachis. Leaf and rachis in transverse section (Figs. 2, 3) showing uredospores in sori, initially under the epidermis, but becoming exposed later. Uredospores large, one-celled, almost hyaline, smooth, nearly sessile, binucleate, with characteristic germ pore, varying greatly in shape and size, subglobose to elongate, the former generally $20 \times 20\,\mu$ and the latter $20 \times 30\,\mu$ (range $20–23 \times 20–30\,\mu$), with walls $3 \cdot 3–4 \cdot 0\,\mu$ thick.

The earlier descriptions of *Hyalopsora polypodii* state that the uredospores are oval or fusiform. The uredospores described here show variations in their morphology. As far as the authors are aware, *H. polypodii* is recorded on *Athyrium filix-fœmina* from Kashmir for the first time and probably from India as well.

We thank Dr. G. B. Cummins, Head, Department of Botany and Plant Pathology, Purdue University, Lafayatte, Indiana, U.S.A., for confirming the identification and Dr. J. P. Tewari, Lucknow University, for helpful suggestions.

Department of Botany,
Lucknow University,
Lucknow, *November* 8, 1968.

B. S. TRIVEDI.
C. L. VERMA.

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* Not seen in the original.

THE ENDOSTYLE,—THE PRIMITIVE THYROID IN THE AMPHIOXUS

THE œsophagus of the amphioxus (*Branchiostoma lanceolatum* L.) has been shown to have diverticulæ like structures arising from it on either side by Azariah.[1] From the microphotographs presented by the author and our own studies, these outgrowths from the proximal gut are the primitive evolutionary counterparts of the thyroid gland of higher animals.

In the phylogeny of the thyroid gland, in the evolutionarily lower groups as the amphioxus, the thyroid gland possesses a duct, opening into the proximal gut, through which the secretions of the thyroid gland were liberated into the gut, from whence they were absorbed for further physiological actions. Thus at this stage it also had a digestive function.[2] In the course of its evolution, the attachment to the gut separated gradually till it became a true endocrine gland as seen in higher animals.

In the amphioxus, this primitive thyroid, i called the endostyle,[3,4] and has the same func. tions as the thyroid gland. Moreover th amphioxus endostyle is known to caus metamorphosis in axolotls.[5] This is similar t the function of the thyroid gland in th amphibia which regulates its metamorphosi as shown by Guternatch, in his experiments

Physiology Research Centre,
B.J. Medical College and Sassoon General Hospitals,
Poona, *November* 19, 1968.

M. J. NARASIMHAN JR.

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REVIEWS AND NOTICES OF BOOKS

Lasers (Vol. 2). Edited by Albert K. Levine. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xi + 440. Price $ 19.75.

Few developments in science have excited the imagination of scientists as has the laser. In the six years since its first realization in the form of pulsed coherent emission from single-crystalline ruby, the field has grown at a rate rarely experienced in science. In addition to the inherent attraction of exploring, characterizing, extending, and exploiting a new physical phenomenon, research in lasers was stimulated by the early experimental verification that coherent radiation could be generated in crystalline systems different from ruby and in other, optically transparent media such gases, glasses, and liquids. Thus, a large research effort in materials research was joined to extensive phenomenological investigations. The field of research was further expanded by the conception and development of highly significant techniques for attaining giant laser pulses, which, in addition to leading the way to extremely high power lasers, provided a tool for the discovery of importants effects such as frequency doubling, the generation of coherent Raman radiation, and for the investigation of non-linear optical effects generally. More recently, additional research has been spurred by notable advances in gas-phase systems, which have made available laser radiation in many lines from the ultraviolet into the far infrared. In sum, even without considering applications, the field has grown so fast and proliferated so broadly that the tendency for scientists to specialize within it is virtually complete. As a result, today probably no individual would profess to be authoritative over the whole field of lasers, or even knowledgeable of most of the significant literature.

Lasers is a series of critical reviews that evaluate the progress made in the field. The contributing authors are scientists who are intimately involved in expanding the research frontiers in their specialities and therefore, write with the authority that comes from personal contribution. The series provides the background, principles, and working information that is needed by physical and biological scientists who seek to use lasers as a tool in their research and by engineers who wish to develop the laser phenomenon for commercial and military applications.

The topics dealt with in this volume under review are: Gas Lasers, by C. K. N. Patel; Glass Lasers, by E. Snitzer and C. G. Young; The Injection Laser, by William P. Dumke; Non-linear Optics, by R. W. Terhune and P. D. Maker; and The Frequency Stabilization of Gas Lasers, by Thomas G. Polanyi and Irwin Tobias.

C. V. R.

Applied Spectroscopy Reviews. Book Edition, Volume 1. Edited by Edward G. Brame, Jr. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. viii + 455. Price $ 16.50.

Applied Spectroscopy Reviews provides information on principles, methods and applications of spectroscopy for the researcher, with discussions that relate physical concepts to chemical applications. Written by noted spectroscopists, the articles cover the entire field of spectroscopy, so that chemists, physicists, biochemists and other scientists who use spectroscopy in their research may benefit from the material presented. Gamma-ray, X-ray, ultraviolet, emission, visible, infrared, Raman, microwave, NMR, ESR, NQR, mass, atomic absorption and internal reflection spectroscopy are among the methods which are examined. Recent advances in the field are reviewed, assessed and critically evaluated, with emphasis on the applications of the latest techniques. The underlying principles of these techniques and applications are also discussed. The book edition, *Applied Spectroscopy Reviews,* is published from the journal edition to make available a complete, durable, hardbound, and fully indexed publication. Organic chemists, biochemists, spectroscopists and students and teachers in various fields will find the book useful.

The contents of this volume are: Atomic Fluorescence Flame Spectrometry; Integrated Intensities of Absorption Bands in Infrared Spectroscopy; Internal Reflection Spectroscopy; Methods and Applications in the Examination of Small Samples by High-Resolution NMR; Chemical Far Infrared Spectroscopy; The

Examination of Polymers by High-Resolution NMR; Infrared Spectra of Adsorbed Molecules; and Instrumentation, Spectral Characteristics and Applications of Soft X-Ray Spectroscopy.

C. V. R.

Treatise on Invertebrate Palaeontology. Part S. *Echinodermata*—1. (The Geological Society of America, P.O. Box 1719, Boulder, Colorado 80302) (in two volumes). Volume 1, Pp. xxix + 296; Volume 2, Pp. 297–650. Hard-bound, Price $ 20.00.

Some of the earlier volumes issued in this arduous undertaking were reviewed in these columns. In preparing this part also the editor and the contributing specialist authors have kept in view the aim of the *Treatise*, namely, to present a complete inventory of present knowledge of invertebrate palæontology concerning the fossil groups they are writing about so that the work may form a foundation for future research in this field.

The echinoderms in Part S are difficult groups in that all are extinct, some having vanished from the earth not less than 500 million years ago, and the latest near the end of Permian time, ca. 200 million years ago. Also it is to be noted that none are closely related to susviving echinoderms. Part S distinguishes many more taxa of homalozoans and crinozoans (exclusive of crinoids) than have been recognized previously.

The special feature of this part is its survey of general characters and ontogeny observed in the phylum and delineations of morphological attributes of the crinozoan and homalozoan classes treated. A close perusal of the two volumes will reveal the present incompleteness in the understanding of the early echinoderms and the wide opportunities that are open for further investigations in this field.

The following are the chief contents of the two volumes—Volume 1: Introduction, by R. C. Moore; General Characters of Echinodermata, by Georges Ubaghs; Echinoderm Ontogeny, by H. B. Fell. *Crinozoans*: Cystoids; Paracrinoihs; Edrioblastoids; Parablastoids. Volume 2: Blastoids; Eocrinoidea; *Homalozoans*: Stylophora; Homostelea; Homoiostelea. Addendum: Camptostromoids; Lepidocystoids; Cymbionites and Peridionites the Unclassified Middle Cambrian Echinoderms.

A. S. G.

Research Bulletins in Mathematics

The Department of Post-Graduate Studies i Mathematics of the University College o Engineering, Bangalore, is bringing out fro time to time Research Bulletins on problem tackled by the group of workers in th department. We have received the following (1) The Transient Solution for Stokes Secon Problem in Magnetohydrodynamics, b N. Rudraiah, (2) Magnetohydrodynami Laminar Flow between Porous Disks, by B. C Chandrasekhara, K. V. Acharya an N. Rudraiah, (3) A Singular Perturbatio Problem of Laminar Flow between Porou Disks, by N. Rudraiah, B. C. Chandrasekhar and R. H. Nagabhushana, and (4) Flow of Conducting Fluid between Porous Disks f Large Suction Reynolds Number, by Rudraiah and M. G. Geetha.

Information about the Research Bulleti can be had from Dr. N. Rudraiah, Universi College of Engineering, Bangalore-1.

A. S. G.

Books Received

Advances in Chromatography (Vol. 7). Edit by J. C. Giddings and R. A. Keller (Marc Dekker, Inc., 95, Madison Avenue, New Yo 10016), 1968. Pp. xviii + 313. Price $ 15.7

Bulletin of the Madras Government Museun Descriptive Catalogue of the Butterflies in t Collection of the Madras Governme Museum. By S. T. Satyamurti. (Direct of Museums, Government Museum, Egmo Madras-8), 1966. Pp. 255. Price Rs. 30·95.

Tables of Spectral Lines of Neutral a Ionized Atoms. (Translated from Russian By A. R. Striganov and N. S. Sventitsk (Plenum Publishing Corporation, New Yo 10011), 1968. Pp. xi + 899. Price $ 40.00.

Spectra of Nucleic Acid Compounds (Translat from Russian). By Tat 'yana V. Venkste and A. A. Baev. (Plenum Publishing Corpor tion, New York 10011), 1968. Pp. viii + Price $ 15.00.

Fundamental Thermodynamics. By Weinreigh. (Addison-Wesley Pub., Readi Massachusetts), 1968. Pp. vii + 231.

Chemistry and Physics of Carbon (Vol. Edited by P. L. Walker Jr. (Marcel Dekk Inc., New York 10016), 1968. Pp. xvii + 3 Price $ 20.75.

1067-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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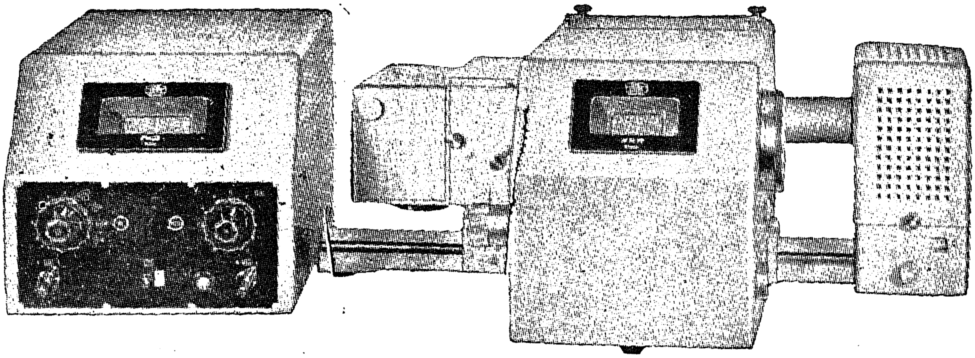

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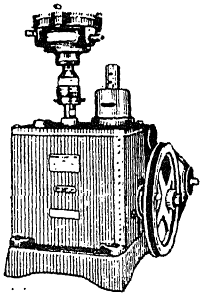

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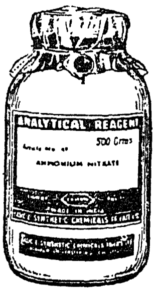

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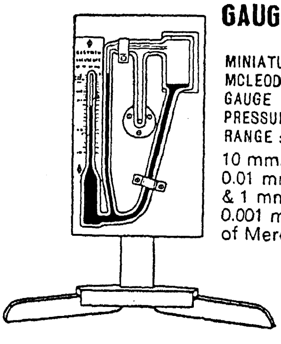

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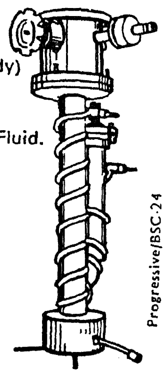

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GENETIC EFFECTS OF SPACE ENVIRONMENT

[Summary of Symposium at the XII International Congress of Genetics Held in Tokyo, 25 August 1968]

S. S. RAJAN

Division of Genetics, Indian Agricultural Research Institute, New Delhi-12

WHEN Yuri Gagarin made his historic space flight in 1961, he took with him *Drosophila* flies to study the genetic effects of space environment. This was perhaps the first genetic experiment in space although genetic effects of space factors like the cosmic rays were investigated as early as in 1935. With the explosive development of space travel, both by manned and unmanned space crafts, the study of genetic effects of space environment like radiation and weightlessness and of space travel like acceleration, vibration, etc., have been under intensive study by both Russian and American geneticists. Their results, however, had not been subjected to a comparative analysis till the 25th August 1968, when both the groups met and presented accounts of their investigations at a Symposium held in Tokyo as a current meeting of the XII International Congress of Genetics. In view of the general interest of this topic, a summary of the principal results reported at the Symposium is presented in this paper.

Eleven papers were presented in three sessions into which the Symposium was divided based on the nature of the test material, *viz.*, (*i*) insects, (*ii*) cells, and (*iii*) plants. Four of the papers were presented by the Russian group, six by the American group and one by Dr. S. Kondo. The titles of the papers are listed at the end of this article. The three sessions were chaired by (1) Dr. R. F. Kimbal and Dr. E. N. Vaulina ; (2) Academician N. P. Dubinin ; (3) Dr. S. Fogel. The Symposium concluded with a final discussion under the Chairmanship of Dr. R. F. Kimbal and Dr. N. P. Dubinin.

In his opening paper, Academecian Dubinin[1*] referred to the challenges of space genetics, termed by him as 'cosmic genetics'. He highlighted the significant role of *Chlorella*, which might accompany man in his space flights both as a source of oxygen and of food, in future researches on space genetics. Among the basic genetical problems involved are, genetic selections to produce new forms adapted to the closed ecological system of space ships ; investigations of evolutionary processes in populations of organisms aboard space ships to create artificial ecological systems, and genetic investigations of extra-terrestrial life forms in terms of molecular, cytological and genetic parameters.

Procedurally the techniques consisted in including the test organisms in space flights, both manned and unmanned, maintaining as far as possible strict ground controls, and testing the organisms after recovery back to earth. The various end-points of these studies were, induction of recessive or dominant mutations, chromosomal aberrations of cell divisions, genetic recombination, etc. Irradiations during space flights were also carried out, in Biosatellite II launched by the American group, with the help of Sr^{85} on board, maintaining a control on the space craft itself through tungsten shielding, as well as on the ground. In the Russian flights, *Vostok-3* and *Vostok-4*, the astronauts crossed virgin *Drosophila* females with males during orbit. Pre- and post-flight treatments ranged from blood samplings from the astronauts to radiation treatments of test organisms and chemical mutagen treatments of *Crepis capillaris*. Although specifically not so designed, the biological systems under investigation provided a size gradient of the nuclei ranging from the biggest in *Tradescantia* to the smallest in bacteria. This permitted Kondo[9] to draw some theoretical conclusions. He inferred that space flight effects as noticed in the aberrations of cell divisions were the weakest in the micro-organisms with small nuclei and most pronounced in *Tradescantia* with the largest nuclei in the group. The total chromosomal mass in *Drosophila* happened to be just on the borderline of direct response to space effects, particularly weightlessness. Even in the micro-organisms, weightlessness can have an indirect effect through intercellular interactions when they are held in a liquid medium. A separation of the indirect effects can be

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[*] Numbers refer to the papers listed at the end of this article.

achieved by adsorbing the cells on a solid surface or by holding them in a solid medium where free movement can be inhibited. This is yet to be tested.

The rest of the papers dealt with mainly an assessment of genetic effects of the space environment and the salient features of these can be summarised as follows:

(*a*) *Effects of Flight Duration.*—As flights are being planned with increasing time of orbiting or space travel, one of the primary areas that require elucidation is whether flight time is an important factor in aberration production. The results are not very conclusive in this regard. While prophage induction in bacteria[6] and aberrant mitoses in *Tradescantia*[12] increased with time in orbit, no correlation with the frequency of recessive lethals in *Drosophila*[2] with the length of flight could be established. Chromatid aberrations in the blood samples from the astronauts showed a tendency of increase with orbiting time.[8] But this was erratic and not consistent. It was concluded that flight time-action response was negative. The flight times considered in these studies ranged from 45 hours of the Biosatellite II to 8 days of the *Vostok* flights. Whether the negative results obtained in these studies would hold good for prolonged periods of weightlessness, a flight to Mars can be as long as 8 months, is an open issue.

(*b*) *Induction of Mutations.*—Active *Chlorella* cultures orbited for as long as 8 days aboard *Cosmos 110* earth satellite showed neither an increase nor a decrease of visible mutations after space flight.[10] The frequency of recessive lethal mutations on the sex chromosome of *Drosophila* (using two lines, high- and low-mutable) showed an increase in three out of seven experiments by the Russian group. A similar increased frequency was not noticed for the dominant lethals.[2] Likewise, in *Habrobracon* an increased frequency of recessive lethals was noticed.[5] But in the test material *Neurospora* included in the same mission as the *Habrobracon*, *viz.*, Biosatellite II there was no effect on the induction of recessive lethals concerning either the entire genome or specifically the *ad-3A* and *ad-3B* loci.[7] Similarly, for the somatic mutations for flower colour in *Tradescantia*, clone 02 heterozygous for this locus, no space flight effects were noticed.[12] It would thus appear that there are more instances of negative results than positive ones with reference to induction of mutations by space environments. In the case of the positive results obtained by the Russian group, the authors themselves feel that this could be explained as a function of the decreased fertility of the male flies due to factors non-specific to space flights.[2] It is interesting to note that in this study one of the genetic effects noticed on *Drosophila* after the space flight was the occurrence of crossing over in the germinal cells of the males in one of the three flights.

(*c*) *Effects on Genetic Recombination.*—The effects of space environment on genetic recombination was also negative in *Habrobracon*[5] as well as in *Drosophila*.[2] Increased recombination in *Drosophila* after space flight, noted by the Russian group, was attributed to temperature effects rather than space specific conditions. Recombination was found to be less frequent under near weightlessness resulting in the decreased probability of prophage P-22 detachment in *Salmonella typhimurium* (P-22)/P-22.[6] (This paper was scheduled but not read at the Symposium.)

(*d*) *Synergism Between Radiation and Space Environment.*—Several studies were devoted to the combined effects of artificial radiation and space environment. The radiation treatments were given as pre-, or post-flight treatments with or without orbital irradiation. In *Drosophila* there was an increase of sex-linked recessive lethals amongst the daughters of irradiated flies during the flight specimens compared with the irradiated ground controls.[3] In the case of *dumpy wing* the increase was nearly four-fold but was estimated to be just significant when allowance was made for the non-normalities of distribution at frequencies as low as 14/20,582 and 4/24,838 for the orbital and control group respectively. Likewise, the frequency of loss of markers from the Y chromosomes among the sons of males irradiated in the pupal stage was significantly higher in the orbited group than in the ground controls. The frequency of translocations between the Y chromosome and the second pair of autosomes among the sons of males pre-flight irradiated with 4,000 *r* units of X-rays was significantly *less* in the during-the-flight irradiated group. Radiation obviously interacts with weightlessness resulting in cell lethal chromosome breakages, loss or exchanges of chromosome elements and sex-linked recessive lethal mutants to a greater degree than irradiation given on earth.

In *Neurospora*, on the other hand, no effects of space flights in combination with gamma-radiation was observed,[7] when the end-points of the study were the survival of heterokaryotic conidia or induction of recessive lethal mutations. In the case of human blood samples there was a slight increase in the frequency of single break chromosomal aberrations but not in that of the multiple break aberrations in the in-flight irradiated group when compared to the control, in the Gemini III flight. However, these results could not be reproduced in the subsequent Gemini XI flight. Presumably the earlier results are to be attributable to sampling errors.[8] In *Tradescantia* radiation induced somatic mutation rates were unaffected by space flight.[12] But increased pollen abortion, stamen hair stunting and chromosome exchanges indicate increased degree of injury by gamma-irradiation during space flight over the earth-based control. This applies to the sensitive stages of both mitosis and meiosis. There appears to be no general trend of synergistic action on radiation effects by space conditions even within the same test organism. Thus, while space factors enhanced the frequency of dominant and recessive lethals when metaphase I oocytes of *Habrobracon* were irradiated almost by a factor 2, transitional oogonia irradiated during flight showed much less damage than ground-based irradiation suggesting even radiation resistance. The maximum enhancement of radiation effects was in the induction of translocations between 2 and 3, and 3 and 4, in *Drosophila* spermatogonia.[4]

The only conclusion that these contrasting results permit appears to be that the enhancing of radiation damage by space factors does not by itself constitute a specific hazard for space flight.

(*e*) *Cytological Effects.*—In higher plants as well as in human cells chromosome aberrations were unaffected by space factors (with or without concurrent irradiation). Exposure of seeds of *Crepis capillaris* to space factors enhanced their sensitivity to ethylenimine treatments after their return to earth,[11] a significant increase in the chromosome rearrangements being found. Disturbances in cell division or mitotic disorders in *Tradescantia* or primary non-disjunction in *Drosophila* were the more pronounced effects of space factors than chromosome aberrations. In *Tradescantia* the spindle mechanism was disturbed both in the microspores and in root-tip cells. These results point to the possibility that a living cell might be affected by space conditions more through an indirect action on the other cellular organelles and processes than through a direct effect on the nucleus.

(*f*) *Other Effects.*—Amongst the many other effects reported upon, the longer life-span of *Habrobracon* females exposed to space conditions than the ground-based controls[5] and disturbances in the sporulation pattern in *Chlorella*[10] are of interest.

In conclusion it may be pointed out that notwithstanding variations in flight factors, like orbiting altitude, acceleration, vibration, closeness to zero gravity, the diversities of test organisms and the differences in their physiological stages of exposure to space conditions, and the divergences in the genetic end-points considered, the similarities in the conclusions drawn by the American and the Russian groups are indeed very striking While the genetic effects of space environment are bound to be probed deeper and deeper with every advancement in space flight technology, to the earth-bound geneticists these results will stimulate thinking on the significance of the role that earth's gravitational force has played in the regulation of cell division, differentiation and other genetic mechanisms in the evolution of higher forms of plants and animals on *terra firma*.

ACKNOWLEDGEMENTS

I am grateful to Dr. Y. Tazima, Chairman, and Dr. S. Kondo, Organising Secretary, International Symposium on the Genetic Effects of Space Environment, for their kind invitation to attend the Symposium.

---

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2. Glembotsky, Ya. L. and Parfenov, G. P., "Genetic Investigations with *Drosophila* in outer space" (Presented by an interpreter).
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4. Oster. I. I., "Genetic effects of zero gravity and radiation".
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11. Dubinina L. G. and Chernikova. O. P., "Space effects in *Crepis capillaris* seeds".

12. Sparrow, A. H., Schairer L. A. and Marimuthu, K.M., "Genetic and cytological studies of *Tradescantia* irradiated during orbital flight" (This paper was presented by F. J. de Serres).

ASHING PROCEDURES FOR BIOMATERIAL*

G. R. DOSHI, C. SREEKUMARAN, C. D. MULAY AND B. PATEL
Bhabha Atomic Research Centre, Health Physics Division, Bombay-85

VARIOUS methods have been adopted for the destruction of organic matter in biomaterial before estimating the mineral content. Usually, biomaterial are ashed either by "dry ashing" or by "wet digestion" methods. The former procedure is most commonly followed in which mineralisation of organic material is achieved by destroying the samples at different definite temperatures.[1] In the latter method, oxidation is carried out by an oxidising agent in solution.[2-4] However, varying degree of losses of elements have been reported during ashing. Methods so far used for the estimation of the loss of trace elements during ashing procedures involved the direct addition of radiotracers to the excised tissues.[1,4] Such addition, however, does not take into account the possible elemental losses from the volatile organometallic complexes in the biological system during the decomposition of tissues. In the present studies, therefore, an attempt has been made to study the loss of elements incorporated in the biological system. This was achieved, by injecting radiotracers into the living system and allowing the animal to live for stipulated period before sacrifice, and followed by various ashing procedures. This laboratory has been studying the radioecology of an arcid clam *Anadara granosa* (Linn.) for the past few years.[5,6] This clam was therefore selected to study the loss of trace elements during ashing procedures.

EXPERIMENTAL

The radioisotopes of high specific activity used in the present study with half-lives and chemical forms are given in Table I. Freshly collected clams were washed in running sea-water and acclimatised at 22° C. Isotopes (about 10-15 mμC/animal) were then injected in the pedal sinus of the bivalve and maintained in filtered sea-water. After about 48–96 hours, these were dissected, the tissue was transferred (8–12 gm.) into a plastic counting vial and the activity was measured by gamma spectroscopy using a well-type NaI (Tl) crystal.

TABLE I
List of radioisotopes injected with the half-lives and chemical forms

Isotopes		Half-life	Gamma energy (meV)	Chemical form used
Iron-59	..	46 days	1·097	Ferric chloride (4 C/gram)
Strontium-85	..	65 ,,	0·513	Strontium nitrate (0·1 mc Sr-89/gram Sr)
Cobalt-58	..	71 ,,	0·810	Cobalt (II) chloride (carrier free)
Zinc-65	..	245 ,,	1·110	Zinc chloride (5 mc/gram Zn)
Cerium 141	..	290 ,,	0·134	Cerium (III) chloride (carrier free)
Manganese-54		291 ,,	0·834	Manganese (II) chloride (carrier free)
Cesium-137	..	28 years	0·660	Cesium chloride (carrier free)

(*a*) *Dry Ashing.*—The tissue from the plastic vial was quantitatively transferred to a silica crucible and dehydrated under an infrared lamp. Ashing was carried out in a muffle furnace at 400° C. and 700° C. for about 24 hours. The ash samples were dissolved in dilute hydrochloric acid and transferred to the counting vial and counted maintaining the same geometry as of the wet tissue.

(*b*) *Wet Ashing.*—The wet ashing was carried out using oxidising liquids, namely, HNO_3, combustion mixture ($H_2SO_4 : HClO_4 : HNO_3$) and mixture of $HNO_3 : H_2O_2$ (Table II).[7-11] Tissue samples were transferred to conical flasks and about 25 ml. of the oxidising liquid was added and kept overnight at room temperature. These were then digested on a hot plate to near dryness. 25 ml. aliquots of respective oxidising liquids were further added in order to complete the oxidation. The digested samples were transferred to the counting vials and counted maintaining the geometry as above.

---

* Contribution to BARC/IAEA Research Agreement No. 155/R5/CF.

TABLE II

List of oxidising liquids and volume used for wet digestion

Oxidising liquid		Volume consumed	Wet weight of tissue
HNO_3 A.R. sp.gr. 1·42	..	100 ml.	8-12 gm.
$HNO_3 : H_2O_2$ (1 : 1 v/v)	..	100 ,,	8-12 ,,
Combustion mixture HNO_3: H_2SO_4: $HClO_4$: H_2O (375 : 450 : 1.0 : 25)		100 ,,	8–12 ,,

RESULTS

Per cent recoveries for the elements studied are recorded in Table III. It appears that there are no significant losses in dry ashing at 400° C. but for cobalt and zinc, where the recoveries were in the neighbourhood of 90% whereas at 700° C., there was significant loss for all the elements studied except for strontium. Similar results were obtained by Saiki *et al.*[1] when ashing was carried out at 800° C. About 31% of cesium was lost at 700° C. This agrees well with the earlier observations of Green and Finn.[12] However, Saiki *et al.*[1] found nearly 96% and 65% loss at 800° C. and 550° C. respectively after 24 hour ashing.

Among the oxidising liquids, combustion mixture and nitric acid—hydrogen peroxide mixture give near quantitative recoveries for all the elements studied. Recoveries obtained for cobalt, iron, zinc and manganese by combustion mixture are in good agreement with those reported by Pijcks *et al.*[4] In the presence of nitric acid alone, on the other hand, there was appreciable loss of cesium and strontium. These losses were rather significant than those observed during dry ashing. Earlier Carius[13,14] observed that mineralisation using nitric acid was quantitative only at high pressures.

From these studies it is suggested that as far as possible dry ashing though convenient, should be avoided for trace element analyses, since during ashing at high temperatures most of the nuclides are lost.[1,4] In addition earlier workers have observed that the chemical reaction of the ash with crucible also, results in significant loss.[10,15] However, dry ashing at low temperatures (450° C.) appears to be the more convenient where large quantities of environmental samples have to be handled for radiochemical analyses. Of the different oxidising liquids used in the present investigation, we obtained for the elements studied, comparable recoveries except with nitric acid. In studies on the concentration of trace elements we prefer the HNO_3 : H_2O_2 mixture for the following reasons: (*i*) Nitric acid and hydrogen peroxide could be easily obtained at the desired level of purity, whereas we found it extremely difficult to purify reagent grade sulphuric acid and perchloric acid, and (*ii*) this

TABLE III

Per cent recovery of trace elements after different procedures of ashing

Ashing procedures		^{59}Fe	^{85}Sr	^{58}Co	^{65}Zn	^{144}Ce	^{54}Mn	^{137}Cs
Dry								
400° C.	..	100·0	100·0	90·8	91·4	100·0	96·2	93·0
		100·0	100·0	..	..	.	..	100·0
700° C.	..	90·7	100·0	64·0	65·8	92·0	90·0	69·7
Wet								
HNO_3	..	97·1	78·3	92·4	95·5	72·9	93·3	79·5
		98·6	81·8	94·9	96·5	83·9	98·4	78·0
		..	91·2	..	100·0	..	100·0	..
		..	94·8	..	..	..	..	..
$HNO_3 + H_2O_2$	..	94·7	94·0	94·5	96·7	98·6	98·4	94·1
		97·7	95·7	97·3	100·0	99·6	98·8	96·0
		..	100·0	97·9	100·0	100·0	98·9	100·0
		..	100·0	..	..	100·0	100·0	..
Combustion mixture		85·3	100·0	88·4	90·7	98·2	94·8	92·4
		88·3	100·0	94·6	96·4	100·0	100·0	94·0
		92·0	..	95·8	96·6	100·0	100·0	100·0
		..	..	97·2	100·0	100·0	100·0	100·0

mixture rapidly mineralises small quantities of tissue at low temperature.

ACKNOWLEDGEMENTS

Our thanks are due to Dr. A. K. Ganguly for his suggestions and presenting this at IAEA Panel of Experts on the reference methods for "Marine radioactivity studies" held at Vienna in November 1968.

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VIRUS ASSOCIATED WITH COCONUT ROOT (WILT) DISEASE

ARVIND S. SUMMANWAR, S. P. RAYCHAUDHURI, K. JAGADISH CHANDRA
Division of Mycology and Plant Pathology

NAM PRAKASH
Division of Agricultural Physics, Indian Agricultural Research Institute, Delhi-12

AND

S. B. LAL
Central Coconut Research Institute, Kayangulam, Kerala

INTRODUCTION

THE root (wilt) disease of coconut is causing a serious concern in southern parts of India where coconut has the largest area under plantation.

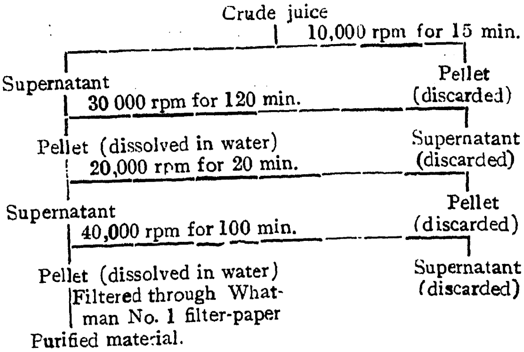
The disease is characterised by symptoms of 'wilt' accompanied by flaccidity of leaflets and abnormal bending of leaves. The outer whorl of leaves often shows yellowing. The leaves are stunted and the crown is reduced. Ultimately, the malady results in considerable reduction in yield.

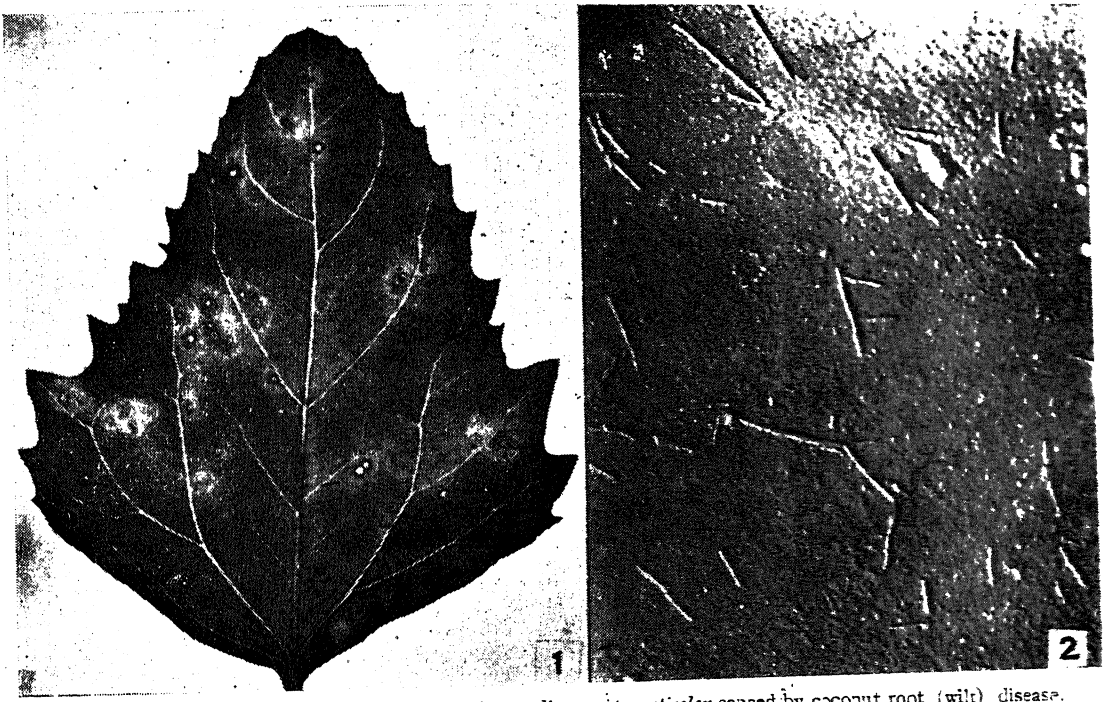
Earlier workers, on the basis of their transmission studies, concluded that the disease may be of virus origin.[3,6] Nagaraj and Menon[3] inoculated several plant species belonging to families Palmæ, Graminæ, Solanaceae, Cucurbitaceæ, Leguminoseæ and others. The disease was mechanically transmitted to cowpea, *Vigna sinensis* Endl.[5] Inoculated cowpea seedlings showed distortion and crinkling of trifoliate leaves.[2]

Although the possibilities of the disease to be of virus nature were indicated by earlier workers, no exact cause was yet established. Therefore, work was taken up in this laboratory, employing electron microscopy (em.) technique and infectivity tests to detect the nature of coconut root (wilt) disease.

EXPERIMENTAL PROCEDURE

Young leaf and root samples were obtained, repeatedly, from severely diseased trees from the Central Coconut Research Station, Kayangulam, Kerala State, where the disease is a major problem. The leaves and roots were macerated separately in a wearing-blender and the material was exposed to low and high ultra-centrifugation (Beckman Model L) in the following way for purification.





FIGS. 1-2. Fig. 1. Local lesions on *Chenopodium amaranticolor* caused by coconut root (wilt) disease. Fig 2. Electron micrograph showing rod-shaped particles associated with coconut root (wilt) disease. × 21 000.

The purified materials thus obtained from the diseased leaves and roots were divided into two lots. With the first lot, various herbaceous hosts, *viz.*, *Chenopodium amaranticolor*, *Nicotiana glutinosa*, *N. tabacum*, *Datura stramonium* and cowpea were inoculated under glass-house conditions for infectivity tests. Similarly, infectivity studies on these hosts were undertaken with crude juice obtained from diseased leaves and roots as well as from healthy leaves obtained from Calcutta.

The other lot was sprayed on formvar-coated grids for electron microscopic studies. These were shadowed with gold palladium alloy (60 : 40) at an angle of about 25° and were examined with a Philips 100 Kv electron microscope Model Em 100 operated at 40–80 Kv.

In the same manner, leaves obtained from Calcutta, where the disease does not exist, and copra water obtained from nuts collected from diseased and healthy plants were purified as discussed above for examination under em.

EXPERIMENTAL RESULTS

In infectivity tests with purified materials obtained from diseased leaves and roots, a few chlorotic lesions appeared on the inoculated leaves of *C. amaranticolor*, a week after inoculation, with a reddish ring at the periphery later (Fig. 1). No infection was observed on several other hosts tested. From lesions thus obtained on *C. amaranticolor*, several *C. amaranticolor* plants were inoculated; virus concentration thus increased and was purified as described above. On examination of this material under em., rod-shaped particles were noticed. The maximum length of the particles is in the range of 320-360 mμ, the width being 24-25 mμ (Fig. 2).

Repeated examination of the healthy and the diseased samples, coconut leaves and roots, under em., after purification, revealed the presence of rod-shaped particles in the diseased specimens, *i.e.,* leaves and roots, but not in healthy ones. These particles are identical in length and width with those obtained from *C. amaranticolor* in em. studies. However, no rod-shaped particles were observed in healthy leaves or in copra water from diseased plants at any time.

DISCUSSION AND CONCLUSION

It has been well established in the present studies, that only the purified materials obtained from diseased leaves and roots are infectious on *C. amaranticolor.* However, crude juice from diseased leaves and roots is non-infectious. Thornberry[7] found that the infectivity of tobacco mosaic virus was directly proportional to the concentration of tannin content. Complete inhibition depends upon concentration of acid and time of action. Bawden and Kleczokowski[1] in their studies with strawberry virus found that none of the strawberry viruses are mechanically transmitted because of high tannin contents in the plants. Verma and Raychaudhuri[8] (in press) also found that *in vitro* potato virus X is almost completely inhibited in the presence of tannic acid of 200 ppm concentration. In the present studies, no infectivity is obtained with crude juice extracted from diseased leaves and roots. Only on purification, infectivity as expressed by local lesions, was observed on *C. amaranticolor* which could easily be multiplied on other plants of this species mechanically. The possible explanation lies in the fact that coconut plants also have high tannic content which must be acting as inhibitor to virus infection with crude material. But on purification, this inactivator is either eliminated or reduced so as to enable the purified material to express infectivity on *C. amaranticolor,* thus indicating the pathogen to be of virus origin.

The purified material obtained from *C. amaranticolor* and that from diseased coconut leaves and roots, when viewed under electron microscopy, repeatedly, revealed the presence of rod-shaped particles which were never observed with the purified healthy coconut leaf material. It is for the first time that electron microscopy technique has been used for detecting the nature of this disease. The rod-shaped particles observed from purified samples of *C. amaranticolor* and diseased leaves and roots of coconut were identical in length and width. However, no rod-shaped or any other kind of particles were observed in healthy leaves of coconut or in copra water obtained from nuts collected from diseased plants at any time. These results, none-the-less, indicate clearly the presence of virus-like particles associated with coconut root (wilt) disease. Electron microscopy is considered to be the most sensitive and sure method over other methods currently operative for the detection of plant viruses.[4]

The infectivity tests and electron microscopy technique have now clearly established that coconut root 'wilt' disease is of virus origin. The etiology and other aspects of the disease are being investigated through further work.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. M. S. Swaminathan, Director of this Institute, for his great interest in this project. Thanks are due to Mr. A. Ghosh, Senior Research Assistant, in this Laboratory, for obtaining leaf samples from Calcutta and to PL 480 authorities, A.R.S., U.S.D.A., for financial support.

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LETTERS TO THE EDITOR

THE BAND SPECTRUM OF TIN MONOIODIDE

A CHARACTERISTIC band spectrum attributable to the diatomic tin monoiodide molecule has been discovered. The spectrum has been observed in emission by exciting a mixture of metallic tin and iodine vapours by a R.F. discharge from a ½ K.W. oscillator. The colour of the discharge appears as characteristic golden yellow. Spectra recorded on Hilger 2-prism Glass—Litrow and Fuess spectrographs reveal a series of red degraded bands extending from λ 6100 to λ 4750. Figure 1 is the reproduction of the Fuess spectrogram on which some of the prominent bands have been marked. All the prominent bands are analysed as belonging to a single system whose vibrational quantum formula is derived as follows:

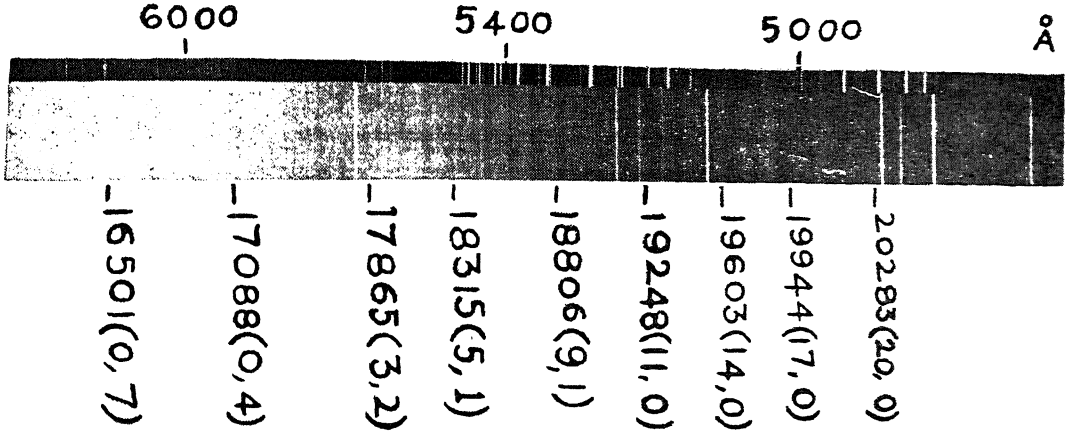

FIG. 1

$$\nu_{(v'v'')} = 17916\cdot7 + 129\cdot8\ (v' + \tfrac{1}{2}) - 0\cdot46\ (v' + \tfrac{1}{2})^2 - 201\cdot6\ (v'' + \tfrac{1}{2}) + 0\cdot53\ (v'' + \tfrac{1}{2})^2.$$

The bands on the lower wavelength side which appear diffuse are those of higher vibrational quanta and exhibit the tin isotope effect. By analogy with similar systems observed in the homologues SnCl[1] and SnBr[2] molecules, the lower state of the system with $\omega_e'' = 201\cdot6$ cm.$^{-1}$ may be identified as one of the components of $X^2\Pi_r$ ground state of the SnI molecule.

Details of the vibrational analysis will be published separately.

Spectroscopy Lab.,
Physics Department,
Andhra University,
Waltair, *January* 20, 1969.

A. ADINARAYANA MURTHY.
P. B. V. HARANATH.

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FORCE CONSTANTS, MEAN AMPLITUDES OF VIBRATION AND SHRINKAGE CONSTANTS OF SILYLACETYLENE

THE infra-red spectrum of silylacetylene has been reported by Reeves *et al.*[1] and by Ebsworth *et al.*[2] A set of force constants has been determined by Duncan[3] following the assignments given in (1). Duncan has suggested from his force constant data that reassignments of Si—C stretching and C ≡ C—H bend frequencies are necessary. He assigns 636 cm.$^{-1}$ band to the C≡C—H bend, but this seems questionable on account of the absence

TABLE I

Observed and calculated frequencies (cm.$^{-1}$).

Symmetry	Designation	Observed	Calculated
a_1	C—H Stretch	3312	3275
,,	Si—H Stretch	2192	2190
,,	C≡C Stretch	2055	2054
,,	Si—H_3 deformation	935	936
,,	Si—C Stretch	659	659
,,	Si—H Stretch	2193	2194
,,	Si—H_3 deformation	946	946
,,	Si—H_3 rock	685	691
,,	C≡C—H bend	668	660
,,	Si—C≡C bend	220	220

TABLE II

Force constants for Si $H_3C{\equiv}CH$ (md/Å)*

Bond-Stretch and Bond-interaction constants		Angle-bending and angle interaction constants		Bond-angle interaction constants	
f_R	3·5490	f_α	0·1212	$f_{r\alpha}$	0·0100
f_D	5·8900	f_β	0·3560	$f_{r\beta}$	0·0227
f_{rc}	16·9000	f_θ	0·1954		
f_r	2·7620	f_ϕ	0·0943	$(f_{R\alpha}-f_{R\beta})$	-0·1024
f_{rr}	0·0310	$f_{\alpha\beta}$	0·0108		
f_{Rr}	0.0383	$f_{\phi\theta}$	0·0733		
f_{rcK}	1·8480				
f_{rcD}	0·0857				

* R refers to the Si—C bond, D to the C—H bond, r_o to C≡C bond and α, β, ϕ and θr refer to H—Si—H, H—Si—C, Si—C—C and C—C—H angles respectively.

TABLE III

Mean square amplitudes (10^{-4} Å^2) and shrinkage constants

Atom Pair	$\langle \Delta Z^2 \rangle$	$\langle \Delta X^2 \rangle$	$\langle \Delta Y^2 \rangle$	$\langle \Delta Z . \Delta X \rangle$	$\langle \Delta X . \Delta Y \rangle$	$\langle \Delta Y . \Delta Z \rangle$	Shrinkage constant
Si—H_1	70·93	75·75	196·95	0·78	0	0	
Si—C_1	31·19	107·40	107·40	—0	0	0	
C_1—C_2	13·38	220·60	220·60	0	0	0	
C_2—H_4	77.18	310·87	310·87	0	0	0	
H_2—H_3	256·09	167·10	485·36	0	13·02	0	
H_1—C_1	139·25	370·96	330·66	—24·92	0	0	
H_1—C_2	197·50	123·18	155·27	—92·47	0	0	
H_1—H_4	323·47	330·50	403·33	—665·10	0	0	
Si—C_2	76·84	22·87	22·87	0	0	0	0·02337
Si—H_4	73·80	278·26	278·26	0	0	0	0·04678
C_1—H_4	63·03	584·10	584·10	0	0	0	0·02191

of such a band in the spectrum of Si $D_3C{\equiv}CH$. In this work we have made use of the assignment given in (2) and a reasonable set of force constants is obtained. Since this set appears to be realistic, the assignment in (2) seems to be more plausible.

Along with the force field, the generalised mean square amplitudes of vibration and the shrinkage constants are also reported here. The observed and calculated frequencies are presented in Table I; Table II contains the force constants; and the generalized mean square amplitudes of vibration calculated at 300° K. and the shrinkage constants are shown in Table III.

Reeves *et al.*[1] report from the evidence of argon matrix spectra that Si—C stretch occurs at 679 cm.$^{-1}$ Insertion of this frequency leads to an unreasonably large value of f_{Si-C}. But by using 659 cm.$^{-1}$ as the Si—C stretch,[2] the value obtained for $f_{Si\ C}$ is in close agreement with that for similar molecules.[3,4]

No electron diffraction data are available at present to compare the computed values of the mean square amplitudes and shrinkage constants.

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Physics Department, Kerala University, Alwaye-4 (India), December 13, 1968.

K. VENKATESWARLU.
M. K. RUDRA WARRIER.
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ELECTRIC MOMENTS OF COMPLEXES OF TRIPHENYLPHOSPHINE WITH ZINC, CADMIUM AND MERCURIC HALIDES

TERTIARY phosphines and arsines form complexes of the type $MX_2.2Y$ with metals of Group II of the periodic table where M is the metal atom (M = Zn, Cd & Hg), X a halogen atom and Y the donor ligand (Y = Triphenylphosphine or arsine). To elucidate the structure of these complexes, their electric moments have been measured in dioxan (D) and benzene (B) at 35° C.

Triphenylphosphine complexes of zinc halides ($ZnX_2.2Ph_3P$) were prepared by mixing hot acetone solutions of the two components and the products recrystallised from the same solvent. $CdI_2.2Ph_3P$ and $HgI_2.2Ph_3P$ were similarly obtained as colourless crystals from hot alcohol.

Benzene and dioxan were purified as described in literature.[1] Measurements of dipole moments were made using the standard technique.[2] The total polarization of the solute at infinite dilution was determined by using the mean values of Hedestrand's constants α and β. The total electron polarization of the compound was taken as the sum of those of the halides and the ligands. The moments of the complexes are given in Table I.

TABLE I

Compound	Solvent	μ. Debyes
$ZnCl_2.2Ph_3P$	D	7.43
$ZnBr_2.2Ph_3P$	D	7.89
$ZnI_2.2Ph_3P$	D	8.30
$CdI_2.2Ph_3P$	B	8.30
$HgI_2.2Ph_3P$	B	7.42
HgI_2	D	2.30

The moment of bistriphenylphosphine complex of zinc chloride (7·43 D) is comparable to the value 7·57 D reported by Curran[3] for dichlorobis-(triethylphosphine)-zinc, representative of a tetrahedral structure. Similar structures are suggested for $CdI_2.2Ph_3P$ and $HgI_2.2Ph_3P$. This is in line with the IR and X-ray measurements for the tertiary aryl and alkylphosphine complexes of these halides by Evans,[4] Coates[5] and Deacon.[6] The increase in moment from zinc chloride complex to the iodide complex is in the same order as the increase in the polarizabilities, iodine > bromine > chlorine. The low moment of $HgI_2.2Ph_3P$ (7·42 D) is due to the lower polarity of the Hg-I bond compared to that of Cd-I and Zn-I bonds.

The zero moments of mercuric halides in the vapour and in the solid states reveal a linear structure.[7] However, the origin of the definite values for the moments of mercuric halides in solution is not yet clear.

The authors are thankful to Prof. M. R. A. Rao for his keen interest in this work.

Dept. of Inorganic and Physical Chemistry,
Indian Institute of Science,
Bangalore-12, *January* 20, 1969.
N. SARASWATHI.
S. SOUNDARARAJAN.

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AMINO-ACIDS OF SOME WILD LEGUMES

PRELIMINARY analysis for proximate principles of seven non-cultivated leguminous seeds of *Cassia siamea, C. absus, C. occidentalis, C. obtusifolia, Albizzia lebbek, A. richardiana,* and *Mucuna pruriens* showed them as appreciably rich sources of proteins and suggested their possible inclusion in animal nutrition. Before including them in the dietary, it was considered pertinent to evaluate their adequacy both qualitative as well as quantitative, as complete proteins with respect to the essential amino-acids listed for normal growth and maintenance.[1] The following describes their free as well as protein-bound amino-acids.

Healthy and dry mature seeds procured locally were powdered to 100 mesh, defatted with petroleum ether (B.P. 40–60° C.) and employed in all investigations. Free amino-acids, separated by paper partition chromatography[2,3] were identified by employing the various special spray reagents.[4-9] Total free amino-acids were estimated by the method of Rosen.[10]

Accurately weighed quantities (25–30 mg.) of defatted seed powders of legumes were hydrolysed with 5·5 N HCl in sealed glass tubes till negative to biuret test. The acid-free hydrolysate after repeated distillation *in vacuo*, was subjected to paper chromatographic analysis and identification. The quantitative determinations of protein-bound amino-acids were made by the procedure of Price[11] and expressed in terms of glycine. The results are shown in Table I.

TABLE I

Protein-bound amino-acids of powdered defatted legumes
(Expressed as mg. glycine per 16 mg. nitrogen)

	Amino-acid		Seeds*						
			1	2	3	4	5	6	7
1	α-alanine	..	3·13	3·21	3·34	1·45	3·97	3·46	3·42
2	Arginine	..	2·35	2·62	–	3·57	2·84	2·27	3·24
3	Aspartic acid	..	3·52	1·91	3·54	3·57	2·84	3·95	2·96
4	Cysteic acid	..	0·43	1·41	–	0·59	0·39	0·89	0·09
5	Glutamic acid	..	4·90	6·29	4·91	8·93	5·96	6·42	8·21
6	Glycine	..	1·99	1·24	2·13	2·53	5·11	4·15	2·05
7	Histidine	..	1·13	1·5	1·21	1·78	2·04	3·56	0·82
8	Leucine-isoleucine	..	6·45	4·63	6·9	7·15	5·11	4·94	7·53
9	Lysine	..	1·37	3·07	1·46	6·55	2·84	0·69	1·68
10	Methionine	..	–	–	0·46	0·59	1·30	0·83	–
11	Phenylalanine	..	1·09	3·18	1·17	1·78	2·10	1·97	1·20
12	Proline†	..	0·43	0·68	0·46	0·44	0·79	1·08	0·18
13	Serine	..	1·96	2·88	2·09	4·17	3·12	2·37	1·93
14	Threonine	..	0·94	1·28	1·04	–	1·81	1·28	–
15	Tryptophan	..	+	–	–	–	+	+	–
16	Tyrosine	..	0·23	0·81	0·25	1·63	0·90	0·49	0·63
17	Valine	..	2·54	2·62	2·72	2· 2	2·84	3·26	2·60
	Free amino-acids‡	..	0·055	0·035	0·32	0·25	0·57	0·71	0·92

* Seeds. 1. *Cassia siamea.* 2. *C. absus.* 3. *C. occidentalis.* 4. *C. obtusifolia.* 5. *Albizzia lebbek.* 6. *A. richardiana.* 7. *Mucuna pruriens.* † Optical density measured at 440 mμ. ‡ Free amino-acids, expressed as gm. amino-acid/100 gm. seed powder, in terms of glycine, + Present, quantity not determined. – Could not be detected.

Chromatography of free amino-acids reveals each seed to possess its own pattern and no single seed is complete in itself with respect to the essential amino-acids in the free state. The total number of amino-acids varies from 9–14, and aspartic acid, glutamic acid, glycine, leucine-isoleucine and serine are common to all seeds.

The wide variation in the total free amino-acid content could be attributed to the various stages of maturity of the seeds and the rate of protein synthesis during seed ripening.

Table I also represents the amino-acid composition of the seed proteins in terms of glycine. Tryptophan is present only in the seeds of *Cassia siamea*, *Albizzia lebbek* and *A. richardiana*, while methionine is detected only in the proteins of *C. occidentalis*, *A. richardiana* and *A. lebbek*. While both the seeds of *Albizzia* appear to be complete with respect to their essential amino-acid composition, methionine and tryptophan are observed to be the limiting amino-acids in others, suggesting that their supplementation with these two acids would contribute towards their nutritional efficiency.

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Biochemistry Section, RADHA PANT.
The University, K. S. SINGH.
Allahabad, *November* 13, 1968.

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FLUORESCENCE, PHOSPHORESCENCE AND SELECTIVE FLUORESCENCE POLARIZATION SPECTRA OF AMINOPYRIDINES

FLUORESCENCE and phosphorescence spectra of 2-, 3- and 4-aminopyridines have been studied at liquid nitrogen temperature in the solid solution. Fluorescence spectra in solution at room temperature have been recently reported[1] when our work was in progress. The fluorescence and phosphorescence maxima for the three isomers are given in Table I.

Absorption spectra due to the spin forbidden electronic transition (singlet-triplet) corresponding to the observed phosphorescence have also been investigated, the data are shown in Table I.

TABLE I

	2-amino-pyridine	3-amino-pyridine	4-amino-pyridine
Fluorescence maxima (in mμ)	345	350	325
Phosphorescence maxima (in mμ)	420	450	360
Singlet-triplet absorption maxima (in mμ)	370	400	..
Longest wavelength singlet-singlet absorption maxima (in mμ)	296	302	270

The separation between the absorption (singlet-singlet) maximum in solution and the wavelength of maximum fluorescence as well as that of absorption (singlet-triplet) maximum and phosphorescence maximum is found to be quite large. This possibly shows that the equilibrium configuration in the excited electronic state is quite different from that of ground state.

It is expected that the longest wavelength absorption in these pyridine derivatives may be a superposition of two transitions, *viz.*, $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$. It was thought that the method of selective polarized excitation in solution could be employed to reveal their existence. The value of p, the polarization in the absence of extrinsic causes of depolarization, depends solely upon the angle λ determined by the direction of the transition moments in absorption and emission concerned. If a sufficiently dilute solution is employed in a medium of high viscosity, all such extrinsic causes may be considered absent and the plot of observed polarization against wavelength of irradiation constitutes the selective polarized excitation spectrum.[2] The limiting values of these polarization ratios are ½ for parallel and 1/3 for perpendicular direction of transition moment. Such a plot obtained for dilute solutions of 2- and 3-aminopyridine in glycerol shows a region of high positive polarization and a region of negative polarization corresponding to the two absorption bands observed at 2900 Å and 2300 Å. Absence of any abrupt change of polarization shows that there is no other electronic transition at the long wavelength end. Presence of $n \rightarrow \pi^*$ transitions would have been detected since $n \rightarrow \pi^*$ and $\pi - \pi^*$ transitions are mutually orthogonal for these planar molecules. Possibility that it is completely superimposed by $\pi \rightarrow \pi^*$ transition is however not ruled out. The fluorescence, however, corresponds to the strong component of long wavelength absorption which doubtlessly is $\pi \rightarrow \pi^*$. As fluorescence intensity in the case of 4-aminopyridine was very low, such a study could not be carried out for this molecule.

Dept. of Chemical Technology, M. R. PADHYE.
University of Bombay, V. V. BHUJLE.
Bombay-19, *January* 22, 1969.

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DIMETHYL SULPHOXIDE AS A CARRIER OF COLCHICINE

INDUCTION of polyploidy through colchicine has been regarded difficult in cereal crops, presumably due to a number of successive leaves surrounding the deep-seated meristem. To overcome the slow entry of polyploidizing agents in cereals several methods have been developed, for instance, decapitating technique in sorghum and maize[4,9,10] shoot-splitting technique in rice[8] and treatment of seeds or buds with colchicine under vacuum. Besides these physical methods, chemicals such as lanolin, glycerine, etc., have also been used as medium for effective treatment.[2] The advent of dimethyl sulphoxide (DMSO) as a penetrant carrier in medicine[5,7] and biology[1,3,6] has led the authors to test the utility of DMSO as a carrier of polyploidizing agent in cereals. A preliminary experiment, carried out in barley and the results obtained are presented here.

Healthy seeds of the barley variety N.P. 104 presoaked in water for five hours were treated for 5 hours with (1) aqueous solution of

TABLE I

Treatment	Period of treatment	Percentage of germination	Growth rate (cm.)		Cytological analysis		
			Root	Shoot	No. of cells	Cells in division	Polyploid cells %
Control	..	43	12·8±0·102	10·7±0·103	500	37·0	..
DMSO (5%)	5 hrs.	38	7·3±0·110	8·7±0·113	501	40·4	..
Colchicine	,,	29	2·4±0·040	0·4±0·027	496	53·6	44·56
Col + DMSO 0·3% (5%)	,,	27	3·7±0·031	0·5±0·058	500	41·2	56·10

DMSO (5%), (2) aqueous solution of colchicine (0·3%) and (3) DMSO (5%) and colchicine (0·3%). Four replicates were taken for each of the above treatments as well as for the control.

The germination percentage in all the treatments was lower than that of the control (Table I). This was also true for the initial growth rate of root and shoot. However, within treatments the germination percentage and growth rate were higher in DMSO than those of the others. Although the percentage of germination in the combination treatment was the lowest, the growth rate of root and shoot was higher than in colchicine treatment. The anomaly was apparently due to an excess of swelling of shoot and root apices. Mitotic studies on the root tip squashes showed mitotic index in all the treatments to be higher than that in the control. Interestingly the values were higher in treatments with colchicine alone than DMSO or DMSO + colchicine, probably due either to the prolonged c-metaphase or the effect of residual colchicine for a longer period in the meristem. Reduced values in combination treatments show introduction of a factor (phenomenon) interfering with persistence of c-metaphase.

The data on relative frequencies of polyploid cells in colchicine and Col + DMSO treatment (Table I) suggests that the latter treatment is more efficient. Thus, enhanced number of polyploid cells and manifestation of excess swelling suggest DMSO to be an efficient carrier of colchicine in barley.

Authors are grateful to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi, for his valuable suggestions.

Nuclear Research Laboratory,
Indian Agricultural Research Institute,
New Delhi, December 30, 1968.

E. A. SIDDIQ.
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ON THE OCCURRENCE OF *PARACONULARIA* IN THE *FENESTELLA* SHALES OF LIDAR VALLEY, KASHMIR*

THIS note records the discovery of a conulariid, *Paraconularia* cf. *P. inæquicostata* (de Koninck),[1,2] in the *Fenestella* Shales[3-5] Series of Kashmir Valley. The collecting locality is a small quarry near the Yanar Fishing Rest House (33° 54′ : 75° 17′; 43 0/5), a little north of the famous tourist resort, Aish Muqam, in the Lidar Valley, Kashmir. Here the lower part of the Series is exposed which mainly consists of black carbonaceous shales with a few bands of limestones, and carries a rich and varied fauna[6,7] consisting of bryozoans, crinoids, trilobites, brachiopods and lamellibranchs, of which *Fenestella* is a conspicuous member, but the brachiopods are preponderant. A brief systematic description of the specimen is given below :

Family	CONULARIIDAE	Walcott, 1866
Subfamily	PARACONULARIINAE	Sinclair, 1952
Genus	*Paraconularia*	Sinclair, 1940

Paraconularia CF. *P. inæquicostata* (DE KONINCK) FIG. 1

The specimen is preserved as an external mould flattened on the bedding plane of a highly fossiliferous black carbonaceous shale. It shows all the morphological characters of the periderm, except the apertural portion which is broken.

Shell fairly large, pyramidal, tapering regularly to apex; sides equal; mid-line of the faces slightly but clearly impressed, disappearing towards the mouth; each half face crossed by thin but moderately strong, elevated, oblique ribs, partially turned back in the front, separated from one another by deep grooves; ribs numerous, 5–10 in 10 mm.; much closer near the summit than on the opposite side; most of the ribs join without alternations so as to form a complete low arch and cross the mid-line of each face without interruptions; rarely the ribs do not cross the mid-line of each face but alternate; interfacial angle infolded, narrow, deep, with ribs from the adjacent faces alternating; preserved length 140 mm.; apical angle 18°.

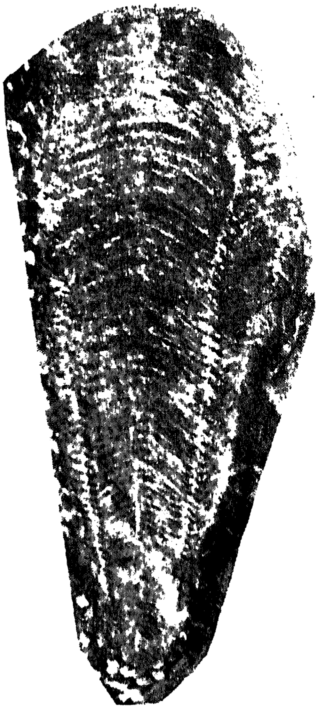

FIG. 1. *Paraconularia* cf. *P. inaequicostata* (de Koninck) Facial view, × 0·6.

The specimen is comparable to *P. inæquicostata* (de Koninck)[1,2] reported from the Lower Carboniferous Limestone group of Belgium. The present specimen was found associated with *Dielasma hastatum* Sowerby and *Syringothyris lydekkeri* Diener, which indicate Lower Carboniferous age.

Repository.—Geological Survey of India Type Number 18275.

The author is grateful to Dr. Patrick K. Sutherland and Dr. Carl C. Branson of the University of Oklahoma, U.S.A., and Dr. Porter M. Kier of the Palæontological Society, Washington, U.S.A., for critical reading of the original manuscript and many constructive suggestions.

Geological Survey of India, K. K. VERMA.
Palæontological Division,
Southern Region, Hyderabad-28 (A.P.),
December 10, 1968.

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* Published with the kind permission of the Director-General, Geological Survey of India, Calcutta-13.

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CANINOPHYLLUM ARCHIACI FROM THE SYRINGOTHYRIS LIMESTONE OF KASHMIR

THE present note records the occurrence of *Caninophyllum archiaci* (Edwards and Haime) from the Syringothyris Limestone exposed in the Kotsu Hill (33° 51′ 30″ : 75° 18′ 00″), near Kotsu, Anantnag District, Kashmir.

Though corallum of *Caninophyllum* are common in the Lower Carboniferous rocks of Europe and Middle to Upper Carboniferous formations of Russia, the present specimen constitutes the first record of this genus from the Lower Carboniferous of Himalayas.

The corallum under description is simple and conical with wide dissepimentarium. Major septa long (Fig. 1) and are united at the

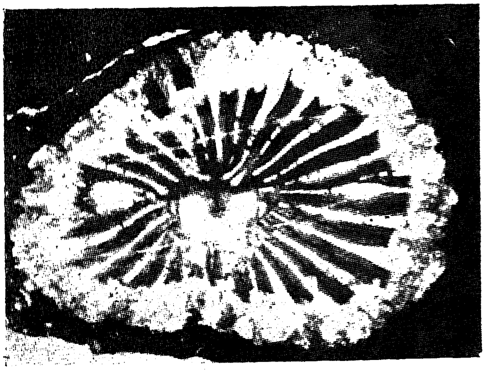

FIG. 1. Transverse Section of *Caninophyllum archiaci* (Edwards and Haime), × 3.

middle of the coral by their attenuated distal ends. The cardinal fossula is conspicuous and occupied by a short cardinal septum.

The present specimen resembles *Caninophyllum archiaci* (Edwards and Haime) described and figured by Lewis.[1]

The author thanks Dr. H. W. Ball, Keeper of Palæontology Section, British Museum of Natural History, London, for providing necessary facilities during the author's visit to the museum.

Centre of Advanced Study in Geology,
Panjab University,
Chandigarh-14, *December* 13, 1968.
V. J. GUPTA.

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HOST-PARASITE RELATIONSHIPS OF *MACROGYRODACTYLUS POLYPTERI* (TREMATODA : MONOGENEA) IN SOME FISHES OF THE SUDAN

Macrogyrodactylus polypteri was first recorded on *Polypterus senegalus* in Gambia.[3] The same parasite was later recorded from the same host in the Sudan.[1,2] It is believed that natural infections of *P. senegalus* with this trematode are always mild and quite tolerable. In confined aquaria, however, parasite density builds up quickly and in some instances may lead to the death of the host.[2]

It has been assumed that *M. polypteri* is host specific, only infecting *P. senegalus* in nature, because two other species of *Polypterus* were never found infected naturally in the Sudan.[2] Two specimens of *Polypterus bichir*, however, recently caught at Jebel Awliya on the White Nile, were naturally infected. The infection was light and few worms were seen on the trunk region, gular plates, opercular flaps and the pectoral fins of the fish. When the infected specimens were placed in a confined aquarium, the infection built up quite rapidly and two days later one of the fish died from heavy parasitæmia. In the meantime, two uninfected fish introduced to the same aquarium developed high parasitæmia and the infection was lethal to one of them which died two days after exposure (Fig. 1). It is therefore evident that *M. polypteri* is not host specific, since virulent infections occur on both *P. bichir* and *P. senegalus*. The susceptibility of other species of fish in the Sudan is under consideration.

The various factors involved in the building up of the parasite populations on a fish are not clearly understood. Repeated observations, however, have indicated that high parasitæmia in fish is always associated with low oxygen concentrations in the aquaria. On one occasion the number of fish dying from heavy infections was great and the infected fish were seen floating near the surface of the water before they died. The O_2 concentration in the water of the aquarium was found to be very low indeed (0·4 mg./l.). On transferring the fish to freshwater with considerably higher O_2 concentration (7·7 mg./l.), there was a spontaneous and significant improvement in the condition of the infested fish and instead of being sluggish and floating near the surface, they began to swim actively to the bottom of the aquarium and came to the surface less frequently. In a series of controlled experiments, it was found that the O_2 consumption of the infested fish was considerably higher than that of the uninfected controls. The difference was highly significant a few hours after the beginning of the experiment. The reasons for this increased O_2 consumption remain to be clarified. A high metabolic rate or increased metabolism due to heavy parasitæmia may be an important factor in this respect.

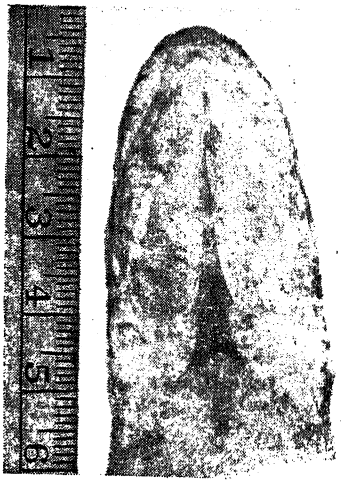

FIG. 1. Ventral view of the head region of *Polypterus bichir* showing heavy parasitæmia.

Observations were made by Khalil (1964) on the development of resistance to re-infection in the fish infected with *M. polypteri*. In our experiments such resistance was not demonstrated. Two specimens of *P. senegalus* which had suffered severe sublethal infections were re-exposed to a second infection few hours after spontaneous recovery from the first infestation. Both fish developed heavy parasitæmia and one of them died two days after the second exposure.

Department of Zoology, University of Khartoum, Sudan, *November* 25, 1968.
M. F. A. SAOUD.
A. MAGEED.

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NOTE ON A CASE OF RHINOSPORIDIOSIS WITH EPIDEMIOLOGICAL SIGNIFICANCE

RHINOSPORIDIOSIS is a well-known chronic mycotic disease affecting man and animal being mostly localized in the nose, less frequently in other sites. Ever since the first report by Malbran[1] in 1892 the majority of cases (94%) have been reported from India, Ceylon, South America, United States and Iran. On the basis of the present epidemiological and related evidences dust, soil or stagnant (pool/pond) water can be incriminated as the possible reservoir of the pathogen *Rhinosporidium seeberi*.[2]

We received a nasal polyp of a patient from Madupatty, Kerala, for investigations. The examination of smear slides and tissue sections stained by H.E. led to its diagnosis as a case of Rhinosporidiosis showing typical large thick-walled sporangia with endospores. Histopathological examination showed that most of the rhinosporidial cysts were present in the connective tissue. Around these cysts, the infiltration by large mononuclear cells was well evidenced. The blood vessels in the affected zone showed distinct congestion and at places hæmorrhage by diapedesis was also noticeable (Fig. 1).

The patient a veterinarian was posted at the cattle breeding dairy and Agriculture Research Centre, Madupatty, in 1954 and had no complaint of any nasal discomfort previously. He first noticed the polyp in April, 1963, which increased in size gradually to the extent that it used to come out while blowing the nose or even on heavy breathing. He was operated upon for the removal of the polyp in May 1964. He has so far no post-operational complaint or any sign of the recurrence of the polyp. During the course of his duties he had to handle cattle and goats. There are two water reservoirs in the farm, the water of which is regularly used for all purposes except drinking by all the inhabitants of the farm. The animals also use the same water for drinking and bathing. On enquiry, it has been found that there is no reported or suspected case of rhinosporidiosis among the human or animals in the farm.

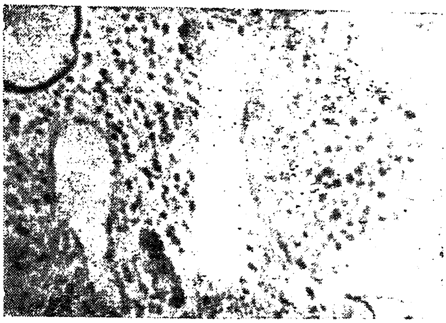

FIG. 1. Section through Nasal polyp stained by Hæmotoxylin and Eosin technique.

It has been suggested by Karunaratne (*loc. cit.*) that the possible method of spread of the disease can be only through soil, dust or stagnant water in form of pool or pond as human to human or animal to human infection is not known to occur.[3-5] The interesting point in the present case is the fact that in spite of handling the animal, using the same water supply this is an isolated single case within the Dairy Farm in the last fifteen years to the best of the knowledge of the patient. The patient also does not give any record of visiting any specific endemic area of rhinosporidiosis where he might have contacted the disease.

These evidences indicate clearly enough that apart from soil or water there are perhaps some other collateral host for the pathogen and a detailed laboratory-*cum*-epidemiological study is called for both in endemic and non-endemic areas to get a better insight into the problem.

Division of Microbiology,
National Institute of
Communicable Diseases,
Delhi-6, *December* 20, 1968.
S. K. SHOME.
M. S. KWATRA.
D. K. MURTY.

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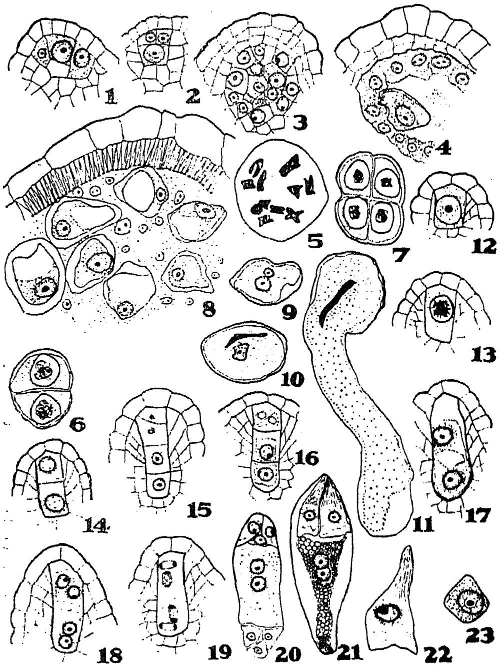
ON THE EMBRYOLOGY OF *CYANOTIS CUCULLATA* KUNTH

GENUS *Cyanotis* Don. consists of 50 species. Our knowledge of the embryology of this genus is restricted to *C. cristata*[1,2] and *C. axillaris*.[2,3] A brief account of the microsporogenesis, megasporogenesis and the development of male and female gametophytes in *C. cucullata* is given here.

C. cucullata grows profusely in the moist clayey soils of Kolhapur during monsoon. The flower-buds in various stages of development were fixed in formaline acetic alcohol. The material, after dehydration and paraffin embedding, was sectioned at 8–18 microns. Sections were stained with Heidenhain's iron-hæmatoxylin and eosin.

Young anther is four-lobed in transverse section. 1–2 hypodermal archesporial initials (Fig. 1) differentiate in each of its corners. The archesporial cell divides transversely (Fig. 2) to produce an outer parietal initial and an inner sporogenous initial. The parietal initial produces the wall layers of the microsporangium. The sporogenous initial undergoes a few divisions to produce a mass of sporogenous cells. The anther wall is four-layered (Fig. 3). The young tapetal cells are uninucleate but some of them become binucleate before the release of the tapetal plasmodium. The cell walls disorganize releasing the tapetal cytoplasm along with nuclei (Fig. 4) during the early prophase of microspore mother cells. The periplasmodium nourishes the dividing microspore mother cells and the young pollen grains and is completely absorbed by the time the pollen grains mature. At the maturity of pollen grains the anther wall has only epidermis and fibrous endothecium. The middle wall layer gets crushed during the maturity of the loculus. Young sporogenous tissue has compactly arranged polygonal cells (Fig. 3). As the spore mother cells mature they get separated from one another (Fig. 4). Ten bivalents were observed at diakinesis stage (Fig. 5). Microspore mother cells undergo successive divisions (Figs. 6, 7). Cytokinesis takes place by cell plate method. Tetrads are isobilateral (Fig. 7). Pollen grains are 2-nucleated (Fig. 9). At the shedding stage, the vegetative nucleus shows signs of degeneration and the generative nucleus elongates considerably (Fig. 10). Pollen grains germinate satisfactorily in 10% sucrose solution. Signs of germination were observed within ten minutes and maximum growth of pollen tubes (Fig. 11) took place within an hour. After their full growth the tips swell up and burst releasing the contents.



FIGS. 1–23. For explanation *see* text. Magnification: Figs. 5, 6, 7, 20, 21, × 320. Figs, 22–23, × 450. All other figs × 225.

Ovules are bitegmic, tenuinucellate and hemianatropous. Archesporium differentiates as a single hypodermal cell (Fig. 12) in the nucellus. It elongates and directly functions as the megaspore mother cell (Fig. 13). Megaspore tetrads are generally 'T'-shaped (Fig. 16) occasionally linear (Fig. 15). Chalazal megaspore is always functional. It develops into an eight-nucleated embryo-sac (Figs. 17-19). The embryo-sac development is of the *Polygonum* type. The mature embryo-sac has an egg apparatus and two polar nuclei lying in the centre of the embryo-sac. Antipodal cells are conical and lie at the chalazal end of the embryo-sac (Fig. 20). They appear as if they are cut off from the main body of the embryo-sac. They disorganize very early and often the mature embryo-sac (Fig. 21) is devoid of antipodal cells. Synergids are conical. Filiform apparatus is well developed (Fig. 22) in mature synergids. The egg cell is pyriform with centrally placed nucleus (Fig. 23). Mature embryo-sac is loaded with simple circular starch grains (Fig. 21).

Botany Department, A. R. Kulkarni.
Shivaji University, V. D. Patil.
Kolhapur, *November* 28, 1968.

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AN INDICATOR SUGARCANE VARIETY FOR RATOON STUNTING DISEASE*.

Ratoon stunting disease (RSD), a virus disease of sugarcane, was first discovered in 1944 in Queensland, Australia, as a disease of yield decline of Q. 28 ratoons.[5] It affects both plant cane and ratoons but is more severe in the ratoons. The disease is severe when the crop is subjected to drought.[5] The two means of recognising the disease are: (1) a pale, salmon pink colour on immature nodes below the growing point of young shoots and (2) orange-reddish discoloration in the vascular tissues of the nodal regions of mature cane stalk when split open. These symptoms are not well defined in all varieties or at all stages of growth of the plant.

Chemical tests[1,2] are not as accurate in diagnosis as the symptoms seen in canes. Another approach is to find a suitable indicator variety which will reveal the presence of RSD virus when inoculated by consistently exhibiting the internal symptoms of pink coloration in young shoots. Schexnayder[4] used C.P. 36–105 as a test plant and it almost invariably exhibited the pink-reddish discolouration of the internal immature region. His technique required 10–15 weeks time after inoculation of single-eye cuttings with freshly expressed infective juice for results. Gillaspie *et al.*[3] found that heat treated C.P. 44–101 gave fairly accurate results in 4–6 weeks time with a pinkish salmon colour in the area of young stem just below the red brown meristematic area.

In an attempt to find out an indicator variety, single-budded setts were made from healthy cane stalks of hot water treated (50° C. for 2 hours) crop of 7 varieties (*See* Table I) the setts dipped for 20 minutes in juice extracted from RSD affected cane stalks of Q. 28 and Co. 421, and they were planted in pots inside the glass-house. After 4–6 weeks from germination, the young shoots were removed close to the mother sett and cut longitudinally with a sharp razor blade. The shoots infected with RSD showed a pinkish-orange colour at the immature nodes of the young stem below the growing point. The results obtained on the transmission of RSD virus are shown in Table I. As will be seen, the variety Co. 421 recorded 100% disease symptoms and showed clearly the pinkish-orange colour in young stem. Similar symptoms were seen in young shoots of Co. 421 under natural infection.

Table I

Percentage of young shoots showing disease symptoms

Ser. No.	Variety	Percentage
1	Co. 419	51·4
2	Co. 421	100·0
3	Co. 449	93·2
4	Co. 658	11·5
5	Co 740	33·7
6	Co 853	94·5
7	Co. 997	96·8

Four hundred and fifty single-budded setts of hot water treated Co. 421 were inoculated as above and planted. Of 376 young shoots observed for the transmission of RSD virus after 4 weeks of growth, 372 (98·9%) showed pinkish-orange colour at the immature nodes of young stem below the growing point and of these 66·7% showed pinkish-orange, 32·2% light pink-orange and 1·1% no symptom. Non-hot water treated shoots of Co. 421 derived from diseased planting material showed 70·8% pink-orange and 29·2% light pink-orange colour. Uninoculated control plants were free of symptoms.

By this technique, the presence of RSD in Co. 740 was confirmed although clear symptoms were not seen in the variety.

The sugarcane hybrid Co. 421 was found to be a good indicator variety for determining the presence of RSD in sugarcane. This biological assay technique will be useful in testing the infectivity of the virus and in determining the presence of disease in sugarcane varieties having disease symptoms, doubtful symptoms and symptomless carriers of the virus.

Thanks are due to Dr. K. V. Srinivasan, Plant Pathologist, for going through the manuscript and suggestions.

Sugarcane Breeding Institute, G. R. SINGH.
Coimbatore-7,
November 18, 1968.

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* Approved for presentation by the Director, Sugarcane Breeding Institute, Coimbatore-7.

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MEIOTIC STUDIES IN *EDGARIA DARZEELINGENSIS* CLARKE; A NEW GENUS OF THE CUCURBITACEAE*

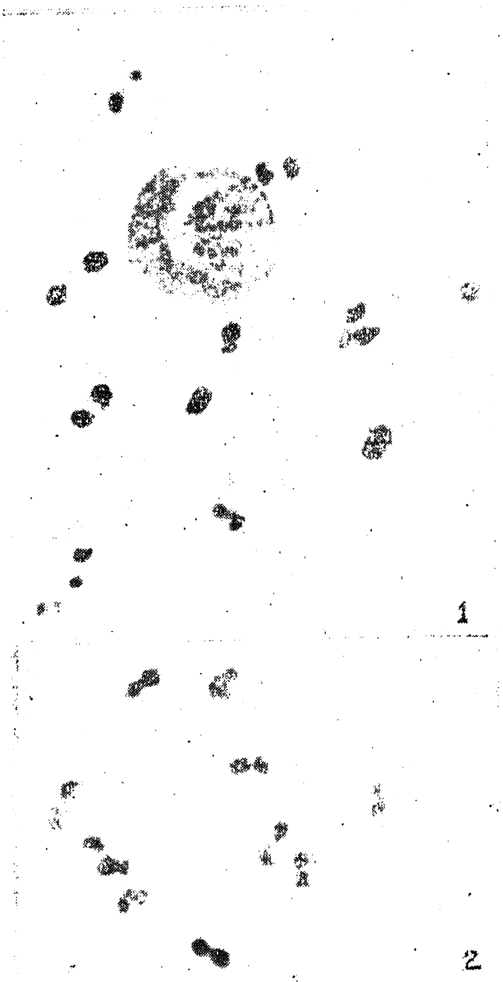
MOST of the Cucurbits are known to be cultivated forms but *Edgaria darzeelingensis* occurs wild in Eastern Himalayas.[1] For the present investigations the collections have been made from the population growing wild in Darjeeling at an altitude of 6000 ft.

Morphologically the genus is distinct from other genera of the family Cucurbitaceæ in having diœcious plants, male flowers with three stamens, fusiform, trigonous, and deeply trivalved fruit. Seeds are pendulous and compressed.

For the cytological investigations, young flower-buds were fixed in acetic alcohol in the field and stored at 0° C. The anthers were squashed in acetic carmine (1·5%) as and when opportunity favoured. The slides were made permanent in butanol series. The photographs were taken from permanent preparations.

A good number of dividing pollen mother cells were seen at diplotene, diakinesis and metaphase I. The chromosomes are deeply stained and scattered in the cytoplasm.

Regular formation of eleven bivalents has been observed (Figs. 1 and 2). One nucleolus is very prominent at diakinesis along with 3-5 small nucleoli. One or two bivalents are seen near the bigger nucleolus and the rest smaller nucleoli have one bivalent near them (Fig. 1). At metaphase I, formation of 5-6 ring bivalents and the rest rod bivalents is found (Fig. 2). The subsequent stages are regular leading to the formation of normal pollen grains.



FIGS. 1–2. Fig. 1. A pollen mother cell of *E. darzeelingensis* at diakinesis showing 11 bivalents, × 1,400. Fig. 2. Metaphase I in a pollen mother cell of *E. darzeelingensis* showing 11 bivalents, × 1,400.

The base number in the genus *Edgaria* is not known, but most of the other genera of Cucurbitaceæ show eleven as the base number. Other base numbers like 7, 8, 9, 10, 12, 13 and 14 are also reported in different genera of the family. Present investigations show that the base number for the genus *Edgaria* is eleven, which presumably is the most common and hence the most primitive base number of the family.

Further the present investigation proves the diploid nature of the species *E. darzeelingensis*.[2]

Although it is a diœcious species, no heteromorphic bivalent has been seen in any pollen mother cell. Therefore, the sex differentiation in this species appears to be controlled at the genic level.

Department of Botany, G. K. THAKUR.
Patna University, B. M. B. SINHA.
Patna-5, *December* 13, 1968. R. P. ROY.

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* The present investigations have been financed by a grant made by the United States Department of Agriculture under PL 480.

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A NEW SPECIES OF *SPHAEROPSIS* ON *MUEHLENBECKIA PLATYCLADOS* MEISSN.

THE authors observed that the phylloclades of *Muehlenbeckia platyclados* growing in the Botanical Gardens of Jodhpur University manifested yellow-brown circular spots. Gradually these spots increased in dimensions and changed to dark-yellow colour. After about a couple of months black fruiting bodies were profusely developed on the upper surface of the phylloclades. Isolations from such spots invariably yielded a richly sporulating culture of *Sphœropsis*. The details of the morphological characters showed that the conidial characters of the present isolate differed from the other known species. The culture was sent to C.M.I., Kew, where it could not be given any specific designation. The isolate is, therefore, being disposed of as a new species, *i.e.*, *Sphœropsis muehlenbeckiœ* spec. nov.

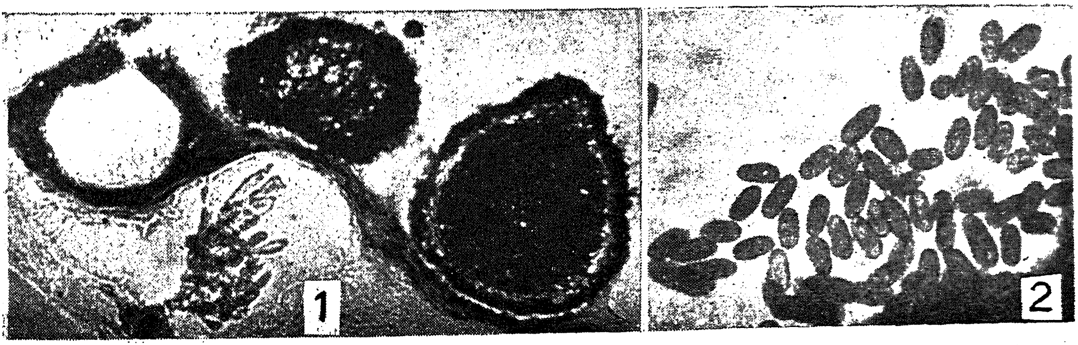
Sphœropsis muehlenbeckiœ SPEC. NOV.

Coloniæ expansæ, juvenes pallide brunneae, maturæ obscure bruneeæ vel atræ, pycnidiis copiosis superficialibus sparsæ; hyphæ hyalinæ vel pallide brunneæ, frequenter septatæ, passim remosæ, 1·4–2·8 μ diametro; pycnidia plerumque bina vel terna. raro singula, juvenia sphærica vel globosa, matura ovata vel subpyriformia, 151·2–302·4 × 168–336 (media 288·2 × 214·4) μ, obscure brunnea vel fusca, ostiolata vel haud ostiolata, conidiis multis complete, pariete e stratis paucis constructo; conidiophora simplicia, brevia. erecta, hyalina vel pallide brunnea, 2·2–3·8 μ longitudine; conidia ovoidea vel elongata, raro irregularia, 11·4–22·2 × 9·5–10·2 (media 20·6 × 9·8) μ, brunneo-lutea vel obscure luteo fusca. Primum in foliis *Muehlenbeckiæ platycladi* Meissn., serius in *Carissa congesta* Willd. lecta :

Cultura in Instituto Respublicæ Mycologico (C.M.I.) Kewensi sub numero 130805 deposita.

Sphœropsis muehlenbeckiœ SPEC. NOV.

Colonies spreading, light-brown when young, dark-brown to black at maturity, with abundant superficial pycnidia; hyphæ hyaline to light-brown, closely septate, poorly branched, 1·4–2·8 μ wide; pycnidia usually in groups of 2–3, rarely separate, spherical to globose when young, ovate to slightly pyriform at maturity, 151·2–302·4 × 168–336 μ (average 288·2–214·4) μ, dark-brown or dark-gray (with or without ostiole), filled with numerous conidia, wall few-layered; conidia ovoid to elongate or rarely irregular, hyaline when young, light brownish-yellow to dark-yellowish-gray at maturity, 11·4–22·2 × 9·5–10·2 (average 20·6 × 9·8) μ; conidiophores simple, short, erect, hyaline to light-brown, 2·2–3·8 μ long. Originally obtained



FIGS. 1–2. Fig. 1. Photomicrograph showing the cross-section of the pycnidia of *Sphaeropsis muehlenbeckiae*, × 189. Fig. 2. Photomicrograph showing the mature conidia of *Sphaeropsis muehlenbeckiae*, × 472·5.

from the leaves of *Muehlenbeckia platyclados* Meissn.

Culture deposited in C.M.I. Kew, Herb. No. 130805.

The fungus was subsequently isolated from the leaf spots of *Carissa congesta* Willd., *Psidium guava* Linn. and *Monstera deliciosa* Liebm.

The authors are grateful to Dr. Donald P. Rogers, Professor of Botany, University of Illinois, U.S.A., for Latin diagnosis of the species, to Dr. G. C. Ainsworth, Director and to Dr. Punithalingam of C.M.I., Kew, England, for sending opinion on the isolate.

Department of Botany, K. S. BILGRAMI.
University of Jodhpur, J. L. SHREEMALI.
Jodhpur, *December* 12, 1968.

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BASIC CHROMOSOME NUMBER IN *BRASSICA*

THE basic chromosome number in *Brassica* was established by Robbelen[1] in 1960 as six through pachytene analysis of its genomes. He further revealed the constitution of its A genome as AA B C DD E FFF and that of B one as A B C DD E FF. In support of these findings, another evidence is provided in the present investigation based on the realization of maximum chromosome pairing in the hybrid between the two genomes.

Crosses were made between the various forms of *Brassica campestris,* viz., *B. campestris* var. *toria, B. rapa* and *B. japonica* belonging to A genome and *B. nigra* (B genome). The hybrids thus produced were extensively studied for chromosome pairing relationship between the two genomes (Table I). The sporocytes of the hybrid generally showed 18 univalents. However, among the bivalents most frequently noted in the meiocytes were 1–6. Seven were rare and observed only in five cells whereas eight were encountered only in three out of 3372 total cells examined (Fig. 1). It seems therefore that eight is the maximum limit of bivalents which could be possible in these hybrids.

TABLE I

Frequency of bivalents in F 1 hybrids of A and B genomes of Brassica *at Metaphase 1*

Cross	Frequency of cells with bivalents									Total number of cells scored
	1	2	3	4	5	6	7	8	0	
Brassica campestris var. Brown sarson × *Brassica nigra*	182	156	61	54	39	54	0	2	819	1367
Brassica japonica × *Brassica nigra*	189	153	56	38	26	49	2	1	432	946
Brassica rapa × *Brassica nigra*	157	81	57	101	112	69	3	0	479	1059

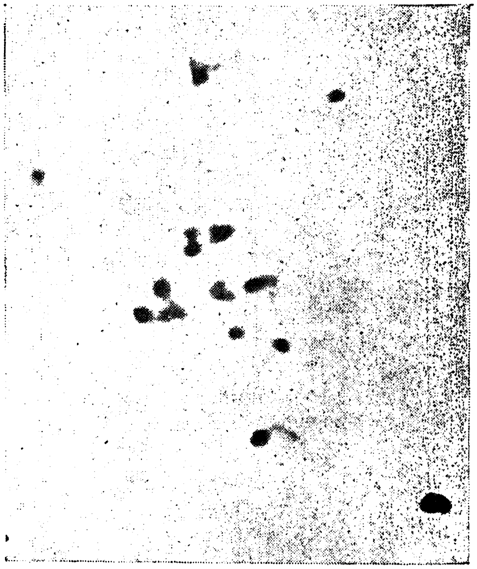

FIG. 1. F_1 hybrid of *Brassica japonica* × *Brassica nigra* showing 8 II + 2 I at M_1.

The 18-chromosome F 1 hybrids of the above cross involving A and B genomes of *Brassica* were reported earlier to form 3–7 bivalents in their sporocytes.[2-4] In the present studies, however, a maximum of eight bivalents in M 1 plate are reported for the first time, The consideration of the genetic constitution of A and B genomes of *Brassica* as given out by Robbelen[1] will reveal that theoretically only eight bivalents can be possible in their hydrids and their realization in the present studies supports the findings of Robbelen in respect of the basic chromosome number in the genus.

The authors are grateful to Dr. H. K. Jain, for helpful criticism.

Division of Genetics, I.A.R.I., New Delhi,
December 13, 1968.
ANUBHAVA NARAIN.
SHYAM PRAKASH.

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DIRECT OBSERVATION OF FUNGAL MYCELIA*

MORPHOLOGICAL changes in the growing tips of fungal hyphæ caused by antagonistic micro-organisms have been reported.[1-5] An *in vitro* technique of direct observation of changes occurring on growing tips of the test fungus (where the influence of the metabolites from the antagonist will be more) in an undisturbed condition is described here.

The central portion of a suitable agar medium in a Petri-dish was cut out leaving only two narrow elliptical strips on opposite sides along the periphery of the dish. These two small strips of agar facing each other were smeared with spores of the test fungus and the antagonist respectively. In the control dish, the test fungus alone was smeared in one of the two strips of agar. Sterilized microscope slides (75 × 15 mm.) dipped momentarily in the same melted sterile medium were used to bridge the two strips (Fig. 1). One or two slides may be used per dish. The dishes can be incubated at any desired temperature. Mycelia of the test organism as well as the antagonist grew towards each other predominantly on the lower sides of the agar-coated slides. The thin layer of agar on the slides facilitated diffusion of metabolites produced by the antagonist, which in turn arrested the growth of the fungus. After the appearance of the inhibition zone (as seen by limitation of the fungal growth) on the underside of the slide, the slides were taken out with sterile forceps and the growth of the organisms on the upper side of the glass slide removed with a scalpel and the agar on the other side trimmed to leave only the affected growing apices of the fungus. This was stained and covered with a coverslip and examined microscopically.

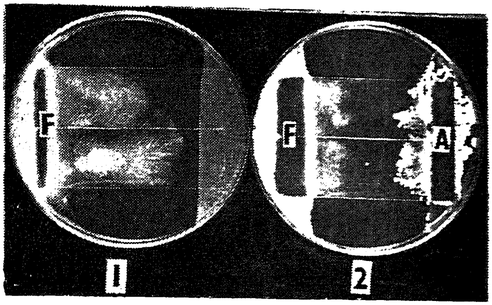

FIG. 1. Petri-dishes showing slides *in situ*
1. Control where test fungus (F) alone was grown.
2. Growth of test fungus (F) and antagonist (A).
(Note the limited growth of the fungus in 2.)

The advantage with this technique is that the growing mycelia, with or without an antagonist, can be observed *in situ* with minimum disturbance.

I am grateful to Prof. T. S. Sadasivan, Prof. C. V. Subramanian and Dr. R. Kalyanasundaram for their valuable suggestions.

The Univ. Botany Lab., Madras-5, *January* 10, 1969.
V. ARJUNA RAO.

---

* Memoir No. 68 from the Centre for Advanced Study in Botany.

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REVIEWS AND NOTICES OF BOOKS

Medicinal Research Series. Volume 3 : *Selected Pharmacological Testing Methods.* Edited by Alfred Burger. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xiv + 515. Price $ 23.75.

Volume 3 of the *Medicinal Research Series* concerns selected pharmacological testing methods based on a critical review and understanding of the normal and abnormal physiological processes for which test methods are designed. Apparatus and procedures, drug-dependence liability, noxious radiation, differential diagnosis and therapy, and placebo effects are examined. Particularly timely is discussion of the effect of one drug upon the metabolism and performance of other drugs. In some cases, where the actual animal tests are primitive and more sophisticated methods of doubtful bearing, the interpretation of the accessible simple test data forms the main portion of a given chapter. The chapter on medical statistical methods presents these in such a manner that those unfamiliar with advanced mathematics may use them readily.

Each contributor has provided the background from his own experience, and from the literature, for the appraisal of the advantages and shortcomings of the tests under discussion.

The following is a list of the topics dealt with in this volume: The Philosophy of Pharmacological Testing, by K. K. Chen; Biostatistics in Pharmacological Testing, by Charles W. Dunnett; Significance of Stimulation and Inhibition of Drug Metabolism in Pharmacological Testing, by G. J. Mannering; Methods for the Appraisal of Analgetic Drugs for Addiction Liability, by Joseph Cochin; Testing for Antihypertensive Drugs, by Walter A. Freyburger; Evaluation of Drugs Affecting the Contractility and the Electrical Properties of the Heart, by Bert Katzung; Ganglionic Blocking Agents, by John A. Bevan; Evaluation of Liver Function Methodology, by Gabriel L. Plaa; Evaluation of Diuretic Agents, by Bohdan R. Nechay; The Evaluation of Drugs Against the Effects of Radiation, by Paola S. Timiras and Antonia Vernadakis; Testing of Drugs for Therapeutic Potential in Parkinson's Disease, by Donald J. Jenden; Evaluation of Antitussive Agents, by Y. Kase; and Evaluation of Sedative-Hypnotics in the course of Psychopharmacological Testing, by Richard F. Tislow.

C. V. R.

Organic Semi-conducting Polymers (*Monographs in Macromolecular Chemistry*, Volume 1). Edited by J. E. Katon. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. x + 315. Price $ 18.75.

This book furnishes detailed information on semi-conducting polymers. The field is considered in its entirety by a group of authors, each of whom has been active in research in the field, and each of whom brings a different point of view to the subject.

The topics dealt with in this volume are: Basic Physics of Semi-conductors, by Dale E. Hill; Theoretical Aspects of the Electronic Behaviour of Organic Macromolecular Solids, by Herbert A. Pohl; Recent Experimental Aspects of the Electronic Behaviour of Organic Macromolecular Solids, by Seiichi Kanda and Herbert A. Pohl; Semi-conducting Organic Polymers Containing Metal Groups, by B. A. Bolto; and Semi-conducting Biological Polymers, by D. D. Eley.

Intended for the synthetic polymer chemist, this book critically reviews the present state of knowledge with regard to semi-conducting organic polymers. The theoretical portions are not intended to be rigorous treatments; emphasis has been placed on providing a treatment of certain concepts that may be used by the reader with little formal training in quantum mechanics, mathematics, or solid state physics.

C. V. R.

Linear Algebra and Its Applications (Published quarterly by American Elsevier Publishing Company, Inc., New York), 1968. Annual subscription: $ 24.00 plus $ 1.00. postage.

Linear Algebra plays a fundamental role in pure mathematics and computer science, and it has wide applications in several other disciplines as well. Therefore there will be general welcome for a journal exclusively devoted to Linear Algebra with the object of publishing advanced research papers and bringing the latest developments in the subject to the notice of the research workers.

The first number of this quarterly journal (Vol. I, 1968) contains original contributions from outstanding persons such as Wilkinson, Marcus, Rado, Hadeler and Dantzig to name just a few among them.

In the opinion of the reviewer, this journal is a welcome addition which will fulfil a long-felt need. P. L. B.

Basic Television (Part I). (Asia Publishing House, Calicut Street, Bombay-1), 1967. Pp. 136. Price Rs. 20.

Rapidly increasing importance of television in the world of entertainment and various other fields such as industry, medicine and research, makes it necessary even for a lay-man to acquire some basic knowledge of the subject. Though the author presupposes in the reader a knowledge of 'basic electricity' the book will make very interesting reading even for a common man.

From the conversion of the optical image (The Scene) into an electrical signal for the purpose of transmission and the re-conversion of the electrical signal to the original optical image with fidelity is a highly complicated process involving complex electronic circuits and other gadgets. Without entering into details of the circuitry, this volume gives a very good insight into the subject from the production of T. V. programmes to its reception. The book is well illustrated.

The contents of the book will provide a good basic knowledge to radio and T. V. engineers and technicians. K. T. B.

Quantitative Chemistry (*Measurements and Equilibrium*). By W. B. Guenther. (Addison-Wesley Publishing Co., Inc., West End House, 11 Hills Place, London W. 1), 1968. Pp. 440. Price 91 *sh*.

This text presents a quantitative study of chemical equilibrium which emphasizes ionic solutions and the study of homogeneous and heterogeneous separation processes. The treatment provides grounding knowledge to enable work to be carried out in the laboratory and arrive at meaningful results and interpretation of data. Plotting data, getting slopes and intercepts, finding maxima and minima, as well as the physical significance of these procedures are stressed throughout.

The book is divided into 26 chapters and the contents may be adapted to a variety of presentation. It is a very useful guide-book for practical work in physical chemistry.

A. S. G.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree to the following in subject mentioned against each : Shri C. Sankara Rao (Chemistry); Shri D. V. Sagar (Technology); Kum. R. Madhavi (Zoology).

Osmania University has awarded the Ph.D. degree to the following in the subject mentioned against each: Shri Rai Lajpat Rai (Mathematics); Shri Thakur Satyanarayan Singh (Zoology) and Shri N. Sampath (Geophysics).

Basic Genetics: L. J. Stadler Memorial Symposium

This Symposium will be held at the University of Missouri, Columbia, Missouri, on May 10, 1969. All interested biologists are requested to contact Dr. Gordon Kimber (Department of Genetics, Columbia, No. 65201) who provides permanent information on request. The lectures of: A. E. Longley—L. J. Stadler the Scientist; E. G. Anderson—Background and Development of Classical Genetics; A. H. Sturtevant—On the Choice of Material for Genetical Studies; T. S. Painter—Chromosomes and Genes Viewed from a Perspective of Fifty Years Research; Curt Stern—From Crossing over to Developmental Genetics; C. C. Lindegren—Biology and Biochemistry: Thesis and Antithesis; A. H. Doermann—Bacteriophage T4, the Present Concept of the Gene; and the discussions will be published shortly in the proceedings. (Subscription price until May 10—$ 4.00; the limited number of copies will be sold for $ 5.00 after that.)

Books Received

Strength of Hard Alloys. By G. S. Kreimer. (Plenum Publishing Corporation, 227, West 17th St., New York 10011), 1968. Pp. viii + 166. Price $ 25.00.

Studies in Number Theory. Edited by A. V. Malyshev. (Plenum Publishing Corporation, New York 10011), 1968. Pp. 66. Price $ 12.50.

Biokybernetik, Band I, Pp. xii + 300; Band II, Pp. x + 277; (VEB Gustav Fischer Verlag, Jena), 1968. Price 45 geb M.

1095-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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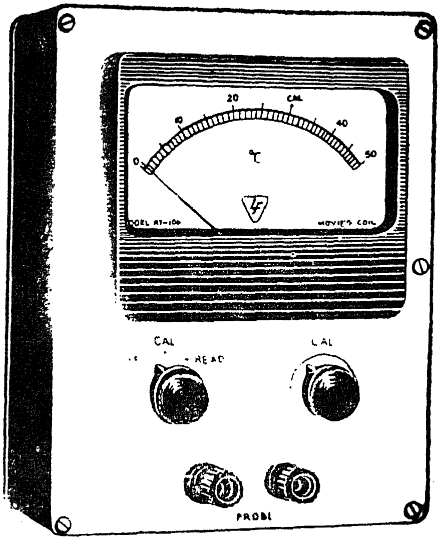

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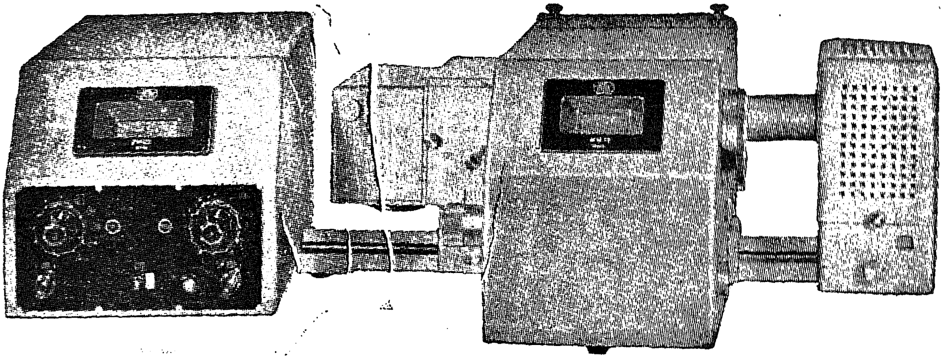

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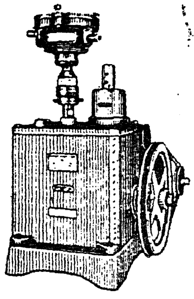

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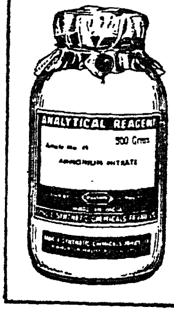

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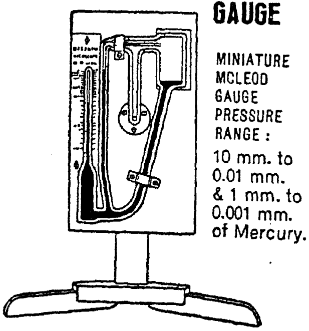

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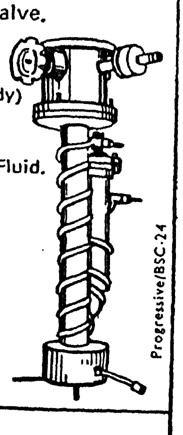

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TRENDS AND PERIODICITIES IN RAINFALL AT WEST COAST STATIONS IN INDIA

P. KOTESWARAM AND S. M. A. ALVI
Meteorological Office, Poona-5, India

1. INTRODUCTION

THE secular trends and variations in rainfall of Indian stations have been studied by many workers, notably Pramanik and Jagannathan (1952) and Rao and Jagannathan (1963). The conclusions arrived at were that neither the annual nor the seasonal (monsoon) rainfall showed any general tendency for increase or decrease at any of the stations or sub-divisions (areas). The methods utilized by these workers were fitting of orthogonal polynomials up to the fifth degree and the ordinary moving averages, mostly of 10 years. All the calculations had to be done manually. The present authors have examined the data of a number of stations with data extending to 100–120 years, utilizing low pass and band pass filters and power spectrum analyses (WMO, 1966). The computations have been done with an IBM-1620 computer. Some of the results of the analyses of SW monsoon rainfall at selected stations along and near the west coast of India are given in the present communication. Fuller details will be published elsewhere.

TABLE I

Stations and rainfall data used in the analyses

	Station	Lat. ° N.	Long. ° E.	Elevation metres	Length of data
Coastal	Bombay (Colaba)	18° 54′	72° 49′	11	1847-1967
	Ratnagiri	16° 59′	73° 20′	35	1869-1967
	Vengurla	15° 52′	73° 38′	9	1871-1967
	Mangalore	12° 52′	74° 51′	22	1864-1967
	Cochin	09° 58′	76° 14′	3	1864-1967
	Trivandrum	08° 29′	76° 57′	. 64	1901-1967
Inland	Poona	18° 32′	73° 51′	559	1856-1967
	Belgaum	15° 51′	74° 32′	753	1864-1967
	Bangalore	12° 57′	77° 38′	897	1837-1967

2. TREND ANALYSES

In order to determine trends or long period variations, a low pass filter with 100 binomial weights was used. The effective number of weights, however, was 31 since the 35th and 65th members of the series carry only 1% of the central weight. The filter eliminates periodicities of 15 years or less and retains only longer periods. The computed rainfall curves obtained after applying the filter are given in Fig. 1. The sunspot curve for the period 1840–1967 treated with the same filter is also given in the figure.

2.1. *Coastal Stations*

The curves for stations north of 14° N—Bombay (Colaba), Ratnagiri and Vengurla—(Fig. 1, *b*, *c*, *d*) show a falling trend towards the end of the 19th century and a generally rising trend in the present century. The rise after 1920 is quite steep. The increase of average rainfall at these stations during the present century is 30–35%.

Stations south of 14° N—Mangalore, Cochin and Trivandrum—(Fig. 1, *e*, *f*, *g*) do not show any trend during the present century. A periodicity of 20–25 years is perceptible in these curves. The power spectrum analyses (Fig. 2), however, do not indicate this frequency.

2.2. *Inland Stations*

The curves for the inland stations—Poona and Bangalore—(Fig. 1, *h*, *j*) which are leeward of the Western Ghats also do not show any trend. Belgaum (Fig. 1, *i*) has a slow rising trend after 1920 and a steeper rise after 1935. The total increase in average rainfall is about 20%.

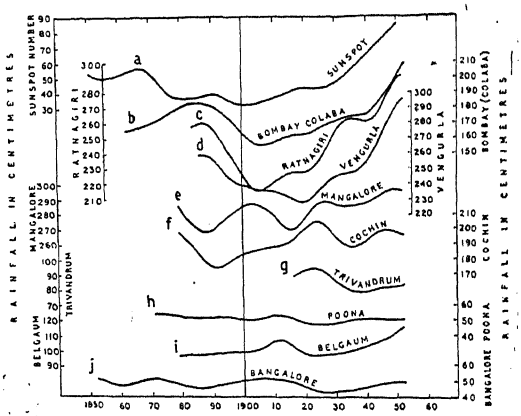


FIG. 1

2.3. *Statistical Significance*

In order to see whether the indicated long period trends are statistically significant, Mann-Kendall test for trend against randomness (Mann, 1954; Kendall and Stuart, 1961) was performed, taking the basic data of the concerned periods into account. The results of the test are given in Table II. If the numerical value in column 5 is greater than that in column 6, the trend is considered to be significant. It can be seen from the table that the increasing trends for the concerned periods during the present century are significant for Bombay (Colaba), Ratnagiri, Vengurla and Belgaum while for the rest of the stations the trends are not significant. The test confirms the conclusions by low pass filter analyses.

TABLE II

Mann-Kendall test of randomness against trend

Sl. No.	Station	Period From	Period To	Rank statistics (r)	Significance $(r)_t = 0 \pm t_g \sqrt{\dfrac{4N+10}{9N(N-1)}}$
1	2	3	4	5	6
1.	Bombay (Colaba)	1851	1900	·030	·183
	,,	1901	1967	·267*	·163
2.	Ratnagiri	1869	1908	·091	·215
	,,	1901	1967	·296*	·163
3.	Vengurla	1871	1917	–·036	–·197
	,,	1918	1967	·369*	·191
4.	Mangalore	1864	1914	·014	·189
	,,	1915	1967	·000	·185
5.	Cochin	1866	1893	–·181	–·252
	,,	1894	1967	·142	·155
6.	Trivandrum	1901	1967	·062	·163
7.	Poona	1856	1924	–·012	–·161
	,,	1925	1967	·116	·207
8.	Belgaum	1864	1900	·162	·225
	,,	1901	1967	·180*	·163
9.	Bangalore	1837	1924	–·003	–·142
	,,	1925	1967	·193	·207

* Significant.

3. POWER SPECTRUM ANALYSES

Figure 2 shows the power spectrum analyses of Colaba (Bombay), Vengurla, Cochin and Trivandrum. A lag of 40 years was adopted for all stations except Trivandrum for which the lag of 20 years was chosen in view of the shortness of the data series. The null continuum as well as the 95%, 90%, 5% and 10% of significance continuum have been shown on each of the figures.

The following are the salient features:

3.1. *Colaba* (*Bombay*) (Fig. 2, *a*)

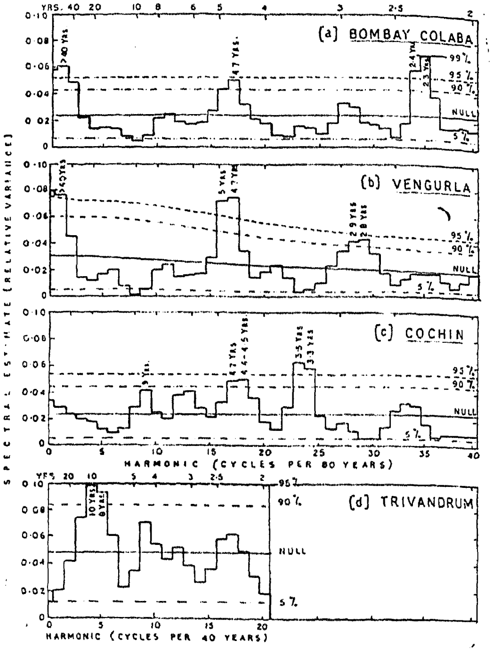


FIG. 2

The null continuum for the station is that of white noise.

(*i*) Spectral estimates for 34th and 35th lag corresponding to a frequency of 2·3 to 2·4 years are significant at 95% level. The 35th lag spectral estimate is significant even at 99%.

(*ii*) Long period trends with a periodicity of greater than 40 years are also significant at 95% level.

(*iii*) Another periodicity of about 4.7 years also appears to be just significant at 95% level.

3.2. *Vengurla* (Fig. 2, b)

Since the lag one correlation coefficient is significant, the null continuum is partly that of red noise.

(*i*) The 28th and 29th lag spectral estimates corresponding to a frequency of 2·7–2·9 years are significant at 90% level.

(*ii*) The 16th and 17th lag spectral estimates are significant at 95% level corresponding to a periodicity of 4·7 to 5 years period.

(*iii*) The long period periodicity of greater than 40 years is also significant at 95% level.

3.3. *Cochin* (Fig. 2, c)

The spectrum is that of white noise. No long period trend is shown by the spectrum. How-shows 23rd and 24th spectral estimates nt at 95% level corresponding to a ty of 3·5 and 3·3 years respectively. it also shows 17th and 18th spectral ; significant at 90% level corresponding riodicity of 4·7 and 4·4 years respec- The ninth spectral estimate correspond- ı periodicity of nine years is almost ıt at 90% level of significance.

vandrum (Fig. 2, *d*)

pectrum is that of white noise. No iod trend is shown by the spectrum ough none of the spectral estimates e 95% significance level, the 4th and tral estimates are quite significant at el corresponding to periodicity of 8 to .

addition to the above stations power analyses have been done for re, Poona and Belgaum, but the are not reproduced here for want of Their salient features are given below.

Mangalore.—The spectrum is that of oise. None of the spectral estimates ficant even at 90% level. Hence re does not show either any periodi- long period trend.

Poona.—The spectrum dots not reveal period trend. However its 17th and ectral peaks are significant at 95% ith reference to the null continuum that of white noise. The periodicities spectral peaks are equivalent to 4·4 years. The 4·4 years periodicity is nificant at the 99% level. A periodicity rs is significant at the 90% level.

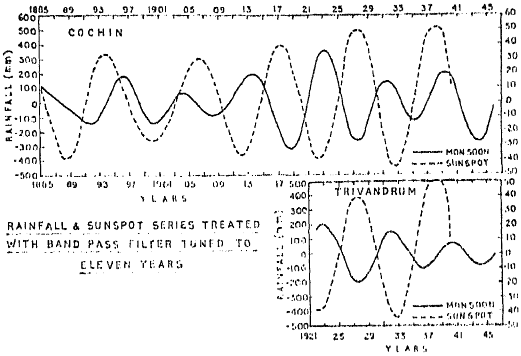
Belgaum.—The spectrum is that of ise. The spectrum shows a long period of greater than 40 years which is ıt at 95% level.

4. SUMMARY OF RESULTS

xistence of a long period trend in the nsoon rainfall at west coast stations 14° N. is revealed by these analyses. trend is seen to the south of 14° N nland stations (except Belgaum). si-biennial oscillation (Q.B.O.) with a y of 2·3–2·9 years is also seen at west tions north of 14° N. A sub-harmonic years is present at Bombay (Colaba), ., Cochin and Poona. Cochin shows ion a periodicity of 3·3–3·5 years. Bhargava and Bansal (1969) also found the Q.B.O. in their power spectrum analyses of Bombay (Colaba) rainfall.

5. RAINFALL AND SUNSPOT NUMBERS

Trivandrum which is the southernmost of the series shows a significant periodicity of 8-10 years (Fig. 2, *d*). When the rainfall series of Trivandrum and Cochin and the sunspot numbers for the corresponding periods were treated with a band pass filter tuned to eleven years, it is seen that in this century the rainfall series and sunspot numbers were in opposite phase, the former curve showing the maximum negative amplitude at the time when the latter had the maximum positive amplitude and *vice versa* (Fig. 3). There has been a shift in phase at both the stations after 1940.



RAINFALL & SUNSPOT SERIES TREATED WITH BAND PASS FILTER TUNED TO ELEVEN YEARS

FIG. 3

The long period trends at Bombay, Ratnagiri and Vengurla follow the trend of the sunspot numbers during this century (Fig. 1). It would appear that the south-west monsoon rainfall along the west coast has been influenced by sunspot activities during the present century.

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DISSOCIATION OF FUNGAL CLUSTERS BY TRYPSIN TREATMENT

M. RAMANUJAM, RADHA SHANMUGASUNDARAM AND E. R. B. SHANMUGASUNDARAM
University Biochemistry Laboratory, Madras-25

INTRODUCTION

BACTERIAL cultures are remarkable in that the cells can be seen through the microscope and counted. The consequent cell division can be followed by cell counting and it is possible to get synchronous cultures. In fungi showing cell differentiation the cells are present as clusters and cell division and macromolecular synthesis cannot be followed by the conventional methods. In our studies on cell division and macromolecular synthesis in *Aspergillus nidulans*, a fungus of the mold type, attempts were made to dissociate the cell clusters into single cells without damage. Trypsin treatment of the clusters was carried out and the resultant single cellular cultures have been studied.

Aspergillus nidulans are propagated by continuous subculture of conidiospores on growth medium. When grown on agar dish, circular colonies are obtained from single spores with conidiation in 48 hrs. In liquid medium with shaking, growth is observed in the form of spherical balls with brush-like surfaces. It has been observed that each spherical cell cluster originated from a single conidiospore[5] due to consequent cell divisions in three dimensions. Attempts were made to break up these clusters to get a unicellular culture and to study DNA replication, synthesis of mRNA, amino acyl-sRNA and peptides with the use of inhibition studies, on an adenineless mutant strain.

MATERIALS AND METHODS

The adenine requiring mutant (FGSC 216) was obtained from the Fungal Genetics Stock Centre (U.S.A.). It was grown in shake cultures. 10 ml. of complete medium[4] was dispensed in each of ten flasks of 50 ml. capacity and were inoculated with about 10^3 spores in 0·1 ml. of suspension, in 0·89% saline and were incubated at room temperature on a metabolic shaker adjusted to 110 strokes per minute. At intervals of three hours the cultures from one of the flasks were taken and centrifuged. A small amount of the residue was smeared as a thin film, on a drop of lactophenol base fixed to microscopic slide, inactivated by heat and stained with cotton blue. The stages of growth observed on the slides are presented in Figs. 1-5.

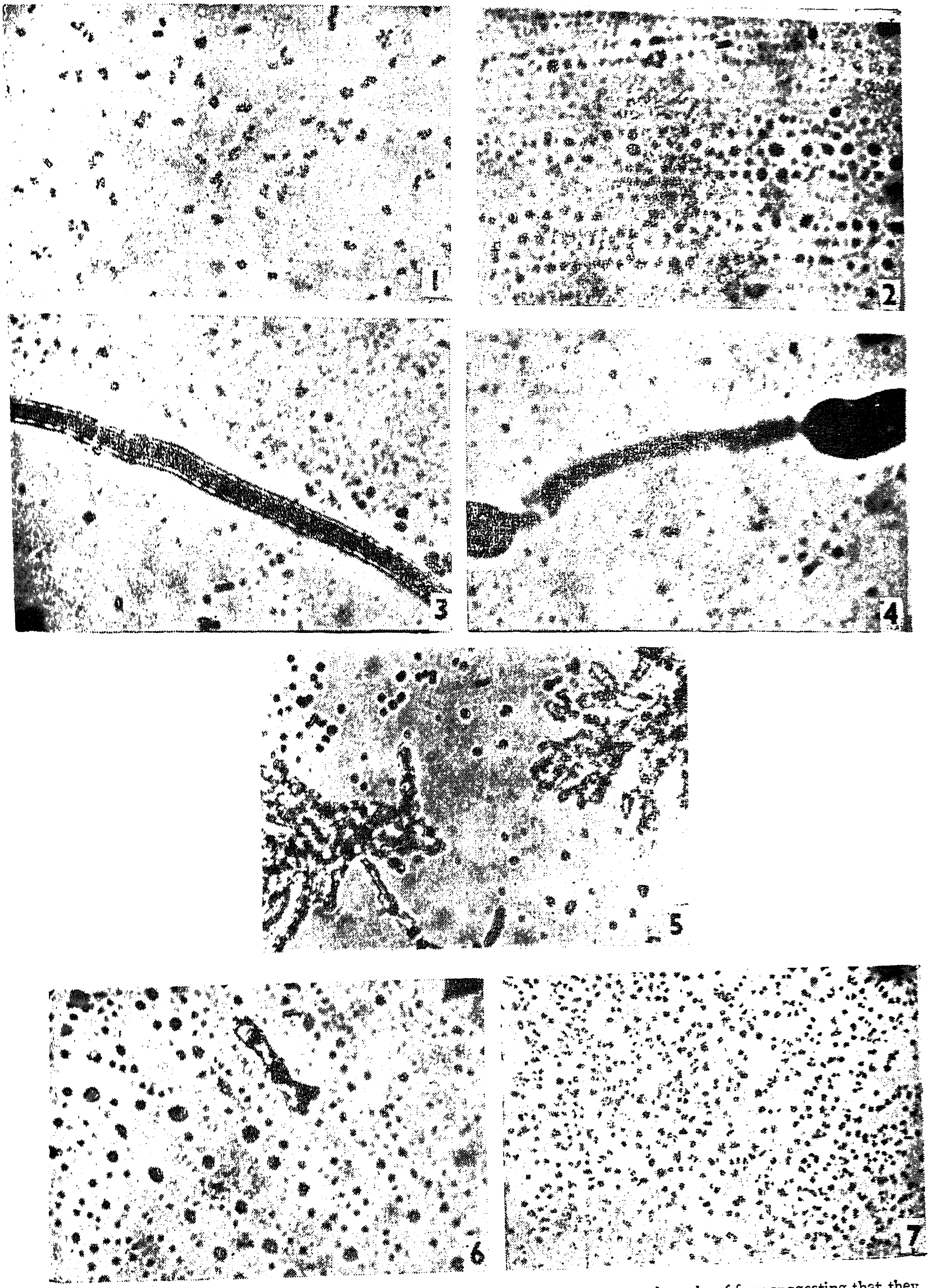
The cells present in 10 ml. of a 24-hr. culture of *A. nidulans* maintained on a metabolic shaker were harvested by centrifugation at 3,000 r.p.m. for 15 minutes. The sedimented cells were washed with water, suspended in Tris-HCl buffer at pH-7·6, and treated with trypsin to a final concentration of 0·25% for 15 mts. At different intervals of time aliquots were centrifuged and the residues smeared as thin films on microscopic slides, inactivated by heat and stained. Photomicrographs of various stages of hyphal disintegration are presented in Figs. 6 and 7. The singled cells were counted on a hæmocytometer under a microscope and the counting verified by plating on the complete medium. Plating method is of paramount importance in determining the number of viable cells present in the medium at a particular instant.

RESULTS AND DISCUSSION

The cell number obtained by plating, agreed satisfactorily with the cell count obtained after trypsin treatment. Continued analysis of the supernatant of tryptic digestion revealed the presence of appreciable amounts of fatty acids and sugars, and of small amounts of proteins, di- and tri-peptides suggesting their involvement in constituting the cell-binding materials. These materials might have cemented the cells into the highly intertwined hyphal structures, which were then dissolved out during trypsin treatment.

The onset of cell lysis is indicated by the appearance of nucleic acids in the supernatant after trypsin digestion. In the slides presented here, the release of the nucleic acids was not observed in 15 minutes, when the cell clusters were broken up to give a uniform single cell suspension. Also any conspicuous decrease in the viable count compared to the direct count under a microscope is indicative of an accelerated rate of cell death[6] which was not observed in our experiments.

The different stages that the cells underwent towards the formation of chaotic hyphal structures were observable under the microscope. The germination of conidiospores, cell



FIGS. 1–7. Fig. 1. The cells are present as clusters of two and three and rarely of four suggesting that they might have resulted from single cells by the budding mechanism seen after 20 hrs. of growth. Fig. 2. The cells grow into beaded structures by unidirectional division, as observed after 24 hrs. Fig. 3. The aligned cells are tightly packed by certain slender fibres as observed after 30 hrs. Fig. 4. The beaded filament is encased in an enveloping sheath as observed at 36 hrs. Fig. 5. The filaments constitute the chaotic hyphal mass after 48 hrs. growth. Fig. 6. Dissolution of cell binding materials by trypsin leaving behind the cells on the ghost-like back-bone material. Fig. 7. The single cells obtained by trypsin digestion for 15 mts.

division by budding mechanism, formation of beaded structures and complex hyphal structures are illustrated in Figs. 1-5. Dissolution of the cell-binding materials on trypsin treatment for 15 mts., is observed in Fig. 6 and the resultant uniform unicellular culture is observed in Fig. 7.

The photomicrographs presented reveal that a unicellular suspension of fungal clusters could be obtained by trypsinization as used in tissue culture studies with higher animals.[1-3] This provides a method of following the cell division in fungus and it is hoped that synchronously dividing cultures could be obtained by this method. With the unicellular suspension as the starting material synthesis of DNA, RNA and proteins in the subsequent generations can be followed using selective inhibition studies.

ACKNOWLEDGEMENT

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SOME STUDIES ON THE WORK HARDENING OF A CHROMIUM-NICKEL AUSTENITIC STAINLESS STEEL

R. VASUDEVAN*

Department of Metallurgy, Indian Institute of Technology, Madras

ABSTRACT

It was noticed that the gradients at the initial portion of the True Stress-True Strain curves of an austenitic stainless steel are very sensitive indicators to low temperature annealing treatments than are the yield points.

INTRODUCTION

It is well known that austenitic stainless steels show a high amount of work hardening. The present study was carried out on a chromium-nickel austenitic stainless steel which was cold-worked to various extents at room temperature and then annealed at various temperatures for a given period of time. True Stress-True Strain curves were drawn for all the samples and both the Yield Points and the gradients of the True Stress-True Strain curves at the initial linear portion close to the Yield Point were determined.

EXPERIMENTAL STUDIES

Chemical analysis of the stainless steel sample revealed its composition to be:

Chromium 19·4, Nickel 11·5, Carbon 0·16, and the rest iron, all in weight percentage.

Rolled bars of the alloy of 15 mm. dia. were initially given a homogenising treatment at 1100° C. for one hour in an argon atmosphere and then quenched in oil. Standard tensile specimens (about thirty pieces) were turned out of these homogenised bars according to DIN 50, 125 specifications. These specimens were then mounted one after the other in a 10 Ton Losenhausenwerk Universal Testing Machine and loaded steadily at the rate of 100 kg. per minute. Reduction in cross-section of the specimen was measured at the centre of its gauge length with a sensitive Kunkel dial gauge. The deformation at the rate of loading adopted was gradual and very uniform over the entire gauge length and very dependable results could be obtained as revealed by repeated studies. True Stress-True Strain curves were plotted in each case from the load-deformation values.

The specimens were divided into Groups A, B, C, D and E depending on the initial deformations given to them which corresponded nearly to 7·5%, 11·9%, 16·5%, 23·8% and 27·6% reduction in cross-section respectively. Each group consisted of at least six specimens. The specimens of each group were, after the initial appropriate deformation, annealed in argon for 1½ hours at 100°, 200°, 300°, 400° and 500° C. respectively—one specimen at each

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* Now at the Institut für Metallkunde, Max-Planck-Institut für Metallforschung, Stuttgart, Deutschland.

TABLE I

Ann. Temp. °C.	Group A—Reduction 7·5%		Group B—Reduction 11·9%		Group C—Reduction 16·5%		Group D—Reduction 23·8%		Group E—Reduction 27·6%	
	Y.P. kg./mm.^{2}	Gradient	Y.P. kg./mm.^{2}	Gradient	Y.P. kg./mm.^{2}	Gradient	Y.P. kg./mm.^{2}	Gradient	Y.P. kg./mm.^{2}	Gradient
32	37·6	0·8640	46·8	0·7134	55·4	0·6697	68·7	0·6020	74·9	0·5682
100	..	..	46·7	0·7563	55·8	0·6757	68·8	0·6142	75·3	0·5771
200	38·0	0·8750	45·9	0·7464	55·4	0·6842	69·0	0·6356	75·8	0·5950
300	38·3	0·8214	47·0	0·7688	56·2	0·6976	69·4	0·6474	75·6	0·6443
350	..	..	..	..	..	..	..	..	75·4	0·6625
400	38·6	0·8723	47·4	0·7408	57·8	0·7916	68·6	0·7131	76·8	0·6767
500	39·8	0·8878	47·7	0·8000	55·7	0·8260	67·8	0·8130	74·5	0·8598
650	..	..	..	..	..	..	..	..	62·0	1·1910

temperature. Specimens of Group E were also additionally studied at 350° and 650° C. After the annealing treatments they were again mounted in the universal testing machine and the fresh True Stress-True Strain curves determined under the same rate of loading as before.

Since work hardening is known to be closely connected with the occurrence of stacking faults in close-packed structures, X-ray diffractometric studies on filed samples of the material were carried out to determine the deformation stacking fault parameter using the formula of Warren and Warekois and obtaining the peak positions of the reflexions as given by Wagner.

RESULTS AND DISCUSSIONS

Table I gives the Yield Point for various reductions of cross-section as also the influence of annealing temperatures on both the Yield Points and the gradient at the initial linear portion of the True Stress-True Strain curves. It is interesting to note that although the Yield Points did not show any decisive variation with temperature (at least at the lower temperature ranges), the gradients of the curves did. In every case, at least for high values of deformation, the gradients increased steadily with increasing annealing temperature showing the onset of some stress relief, possibly due to some cross slip, climb or a stabler arrangement of dislocation tangles. This effect is probably not strong enough to produce any appreciable effect on the Yield Point, but its effect on the gradient is quite palpable. For example, it may be noticed that a specimen of Group E when annealed to 650° C., undergoes a reduction in Yield Point of 17%, whereas the increase in gradient for the same two cases is of the order of 110%. However this effect is not so clear for low deformations as for high deformations as can be seen by comparing values for 7·5 and 11·9% with those of 16·5, 23·8 and 27·6%. In the former case they are rather vague and erratic. Deformations of higher value might have produced even more impressive results but, in practice, when the deformation at room temperature exceeds about 30%, necking and fracture set in fast and sufficient number of dependable experimental points cannot be easily obtained.

Stacking fault parameters were estimated from the peak shifts observed with the pair of lines (111) and (200). Although these peak shifts were compared with the peak shifts of the lines (200) and (220), the values quoted herein are only those obtained from the former pair. It was noticed that the material showed a faulting parameter of about $1 \cdot 55 \times 10^{-2}$ at room temperature or put otherwise about one close-packed plane in 65 is faulted. Assuming the stacking faults to extend infinitely across a plane, this is equivalent to a mean spacing of about 135 Å between successive faulted (111) planes. The faulting fell with increasing temperature and became almost zero at about 500° C. agreeing with studies on some other types of austenitic stainless steels (Table II). It is significant that the Yield Point also starts falling perceptibly at about this temperature.

TABLE II

Annealing Temperature	$(2\theta_{200}-2\theta_{111})^\circ$	Peak shift $\Delta\,(2\theta_{200}-2\theta_{111})^\circ$	Deformation stacking fault parameter $\alpha\,(\times 10^2)$
32° C.	8·56	0·10	1·55
340° C.	8·59	0·07	1·1
500° C.	8·63	0·03	0·5
700° C.	8·66	0·00	0

ACKNOWLEDGEMENT

It is a pleasure to thank Professor Dr. E. G. Ramachandran for his interest in the work.

LETTERS TO THE EDITOR

AN AXIALLY SYMMETRIC LINE ELEMENT AND RELATIVE MASS IN GENERAL RELATIVITY

FOLLOWING Bergmann[1] one can use the field equation

$$\nabla^2 \gamma_{\mu\nu} = 0, \tag{1}$$

along with the co-ordinate conditions

$$\gamma_{\mu s,\, s} = 0, \tag{2}$$

as the basis of derivation of a linearized first order axially symmetric line element outside a mass point. In the first order approximation one takes the metric tensor $g_{\mu\nu}$ as follows:

$$g_{\mu\nu} = \epsilon_{\mu\nu} + h_{\mu\nu}, \tag{3}$$

along with

$$h_{\mu\nu} = \gamma_{\mu\nu} - \tfrac{1}{2}\, \epsilon_{\mu\nu}\gamma, \tag{4}$$

where $\epsilon_{\mu\nu}$ corresponds to the flat space metric, and $h_{\mu\nu}$ is the first order small perturbation in $\epsilon_{\mu\nu}$. Here and in what follows Greek suffixes takes values 1, 2, 3, 4, and Latin suffixes takes values 1, 2, 3.

One may write the axially symmetric solutions of Laplace's equation (1) as follows:

$$\gamma_{44} = \left(\frac{a}{r} + \frac{b}{r^2}\cos\theta\right), \tag{5}$$

$$\gamma_{4s} = \left(\frac{c}{r} + \frac{d}{r^2}\cos\theta\right)_{,\, s} \tag{6}$$

and

$$\gamma_{st} = \left(\frac{f}{r} + \frac{g}{r^2}\cos\theta\right)_{,\, st} \tag{7}$$

where a, b, c, d, f, g are all constants. It is easily seen that the co-ordinate conditions (2) are automatically satisfied as (5-7) are spherical harmonics.

In order to simplify these solutions further, one may carry out the following co-ordinate transformation:

$$v^4 = \left(\frac{c}{r} + \frac{d}{r^2}\cos\theta\right), \tag{8}$$

and

$$v^s = -\frac{1}{2}\left(\frac{f}{r} + \frac{g}{r^2}\cos\theta\right)_{,\, s} \tag{9}$$

where

$$\xi^{*\alpha} = \xi^{\alpha} + \lambda\, v^{\alpha}\,(\xi^{\rho})$$

in Bergmann's notation.

Use of (8-9) in the equation

$$\gamma^*_{\mu\nu} = \gamma_{\mu\nu} - \epsilon_{\alpha\nu}\, v_{1\mu}{}^{\alpha *} - \epsilon_{\alpha\mu}\, v_{1\nu}{}^{\alpha *} + \epsilon_{\mu\nu} v_{1\rho}{}^{\rho *} \tag{10}$$

gives one the following, in the new co-ordinate system:

$$\gamma^*_{44} = \left(\frac{a}{r} + \frac{b}{r^2}\cos\theta\right), \tag{11}$$

$$\gamma^*_{4s} = 0,$$

and

$$\gamma^*_{st} = 0.$$

This gives, on removing now the star symbol,

$$h_{11} = h_{22} = h_{33} = h_{44} = \frac{1}{2}\left(\frac{a}{r} + \frac{b}{r^2}\cos\theta\right). \tag{12}$$

Putting $a = -4m$ and writing $\frac{1}{2}b$ for b, with the use of (3) one gets the following as an axially symmetric line element:

$$ds^2 = \left(1 - \frac{2m}{r} + \frac{b}{r^2}\cos\theta\right)dt^2 - \left(1 + \frac{2m}{r} - \frac{b}{r^2}\cos\theta\right)(dr^2 + r^2 d\theta^2 + dz^2). \tag{13}$$

It may be of some interest to find an equivalent line-element in curvature co-ordinates, and then to compare this with the linearized form of Kerr Metric.[2] One may then be in a position to assign some physical meaning to the parameter b.

Following Narlikar,[3] one may see that (13) also admits an integral like the Schwarzschild metric. The fourth component of the geodesic equation

$$\frac{d^2 t}{ds^2} + \Gamma^{\nu}_{\mu\nu}\, \dot{x}^{\mu}\, \dot{x}^{\nu}\left(\frac{dt}{ds}\right)^2 = 0, \tag{14}$$

with the use of (13), provides an integral from

$$\frac{d}{ds}\left(\alpha_4 \frac{dt}{ds}\right) = 0, \tag{15}$$

where

$$\alpha_4\left(1 - \frac{2m}{r} + \frac{b}{r^2}\cos\theta\right).$$

One then gets for the relative mass m, the following expression:

$$m = \frac{m_0 k}{\alpha_4}, \tag{16}$$

where m_0 is the proper mass and k is the constant of integration.

The interpretation of (16) remains the same as has been given by Narlikar[3] and Dadhich.[4]

My sincere thanks are due to Professor P. C. Vaidya for suggesting me the way out of finding the line-element (13).

Department of Physics, N. K. SHARMA.
University of Rajasthan,
Jaipur (India),
January 22, 1969.

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LOW ENERGY THERMAL NEUTRON CAPTURE GAMMA-RAYS FROM Cd AND Sm

A SIMPLE experimental technique described earlier[1] was employed to investigate the low energy gamma-rays and their absolute intensities from ^{113}Cd(n, γ) ^{114}Cd and ^{149}Sm(n, γ) ^{150}Sm reactions. A 2 Curie Po-Be neutron source, whose neutrons were thermalized by means of a paraffin howitzer, was used in this work. A single crystal scintillation spectrometer was employed to analyze the low energy gamma components. The absolute intensities, I_γs, defined as the number of photons emitted per 100 neutron captures were determined by a Boron comparison method as described in reference 2. All the necessary corrections for self-absorption in the target, absorption in the LiF shield that protected the detector from neutron irradiation and the photopeak detection efficiency of the scintillator were applied to the observed gamma intensities.

The standard form target was made out of natural boron powder in the form of a disc with a $n\sigma$ value one. The capture gamma-ray spectrum from boron was scanned and corrected for the background. Cd was taken in the form of a foil with thickness corresponding to a $n\sigma$ value unity. Sm was taken in the form of a thin disc prepared out of Sm$_2$O$_3$ with a $n\sigma$ value one. The capture gamma-spectra from Cd and Sm are shown in Figs. 1 and 2 respectively. The energies and absolute intensities of the observed gamma components were determined from a prior energy calibration of the system and by assuming the I_γ of the 478 keV line from ^{10}B(n, α)^{7}Li* reaction[2] caused in natural boron to be 93·5 photons for

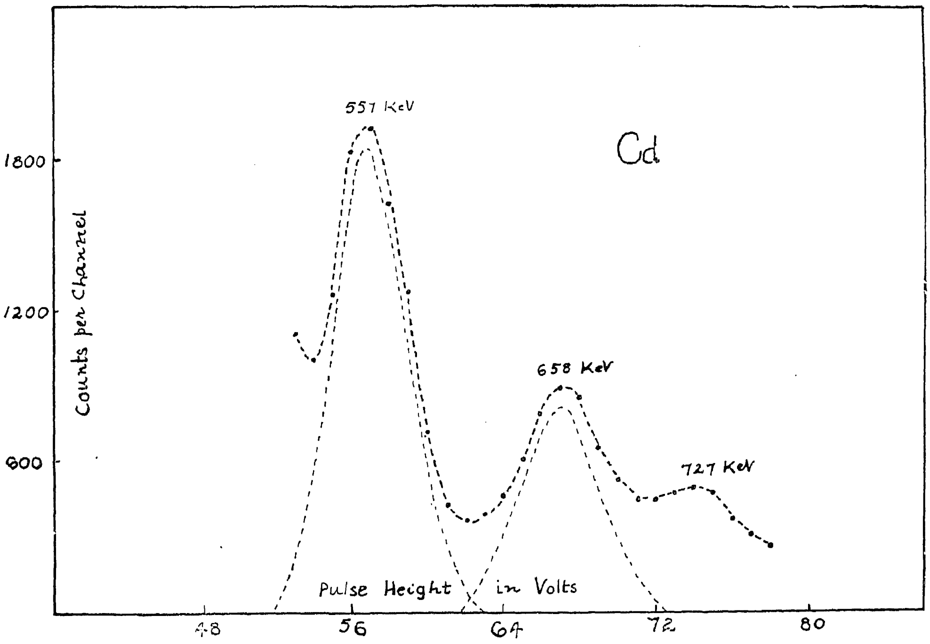

FIG. 1. Gamma spectrum from cadmium produced by slow neutron capture. The upper dashed curve gives the distribution without shape correction. The lower dashed curve represents the corrected distribution.

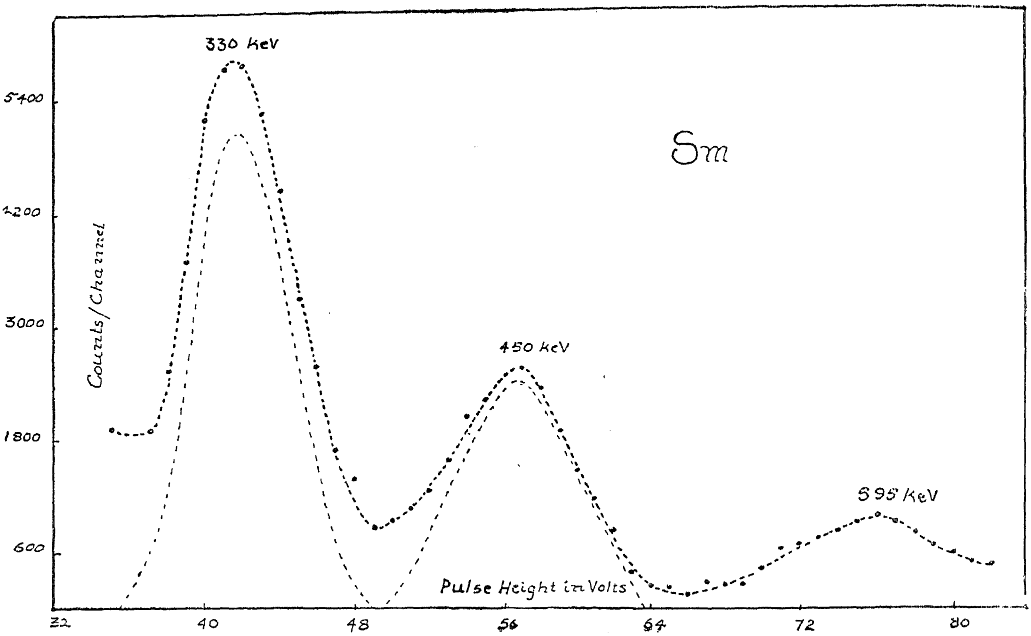

FIG. 2. Gamma spectrum from Sm_2O_3 produced by slow neutron capture. The upper dashed curve gives the distribution without shape correction. The lower dashed curve represents the corrected distribution.

100 neutron captures. The results in their final form are given in Table I. The intensity of 727 keV and 595 keV gamma lines of Figs. 1 and 2 respectively were not obtained as there might be contributions to them from the neighbouring high energy gamma lines.

TABLE I

Energies (E_γ) of gamma components and their absolute intensities (I_γ) expressed in number of gamma photons for 100 neutron captures

Product nucleus	E_γ (keV)	$I_\gamma \pm 15\%$
$^{114}_{48}Cd$	557±6	63
	658±7	28
	727±8	..
$^{150}_{62}Sm$	330±4	73
	450±5	39
	595±6	..

The values of energies and absolute intensities of gamma-rays reported here are in good agreement with those of the previous workers given in (n, γ) atlas[3] who employed altogether different methods. The large intensities of the low energy gamma components indicate the intense population of low-lying excited states both in ^{114}Cd and ^{150}Sm in decaying from their capture states.

The Labs. for Nuclear Research,
Andhra University,
Waltair, India, *January* 13, 1969.

D. L. SASTRY.
K. PARTHASARADHI.
S. JNANANANDA.

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EFFECT OF ALKALI CONCENTRATION IN THE SELF-CONDENSATION OF THE *ORTHO* METHYLOL PHENOLS

IN the condensation reactions of the methylol phenols in presence of alkali Granger[1] has reported that increasing the amount of caustic above a certain point had no further effect on the rate of the reaction. Similar results were obtained by Sprung and Gladstone[2] for which no explanation has been offered. Results of a detailed investigation of the condensation reactions of 2- and 2, 6-dimethylol phenols under different alkali concentrations are reported here.

The reactions were carried out by the method described earlier.[3] The change in the concentration of the methylol phenols was followed by chromatographic separation and spectrophotometric estimation. The results are presented in Tables I and II.

TABLE I

Self-condensation of saligenin at different alkali concentrations. Temp.: 80° C.

Time in minutes	NaOH : 0·003 N Saligenin m/l × 10^3	Saligenin reacted m/l × 10^3	% of saligenin reacted	NaOH : 0·006 N Saligenin m/l × 10^3	Saligenin reacted m/l × 10^3	% of saligenin reacted	NaOH : 0·02 N Saligenin m/l × 10^3	Saligenin reacted m/l × 10^3	% of saligenin reacted	NaOH : 0·04 N Saligenin m/l × 10^3	Saligenin reacted m/l × 10^3	% of saligenin reacted
0	39·65	..	..	41·47	..	..	39·86	..	..	41·33	..	..
30	39·16	0·49	1·24	40·34	1·13	2·73	39·16	0·70	1·76	40·86	0·47	1·14
60	38·62	1·03	2·60	39·00	2·47	5·96	38·34	1·52	3·81	40·53	0·80	1·94
90	37·80	1·65	4·16	37·66	3·81	9·19	37·59	2·27	5·69	..	..	..
120	36·90	2·75	6·93	36·58	4·89	11·80	..	..	..	39·80	1·53	3·70
150	..	..	..	35·33	6·14	14·81	36·21	3·65	9·16	..	..	..
180	35·17	4·48	11·30	34·53	6·94	16·74	..	..	..	39·00	2·33	5·64
240	33·79	5·86	14·78	32·80	8·64	20·84	34·48	5·38	13·50	38·20	3·13	7·57
360	..	..	..	..	..	..	31·72	8·14	20·42	36·67	4·66	11·27

TABLE II

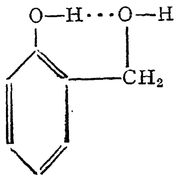
Self-condensation of 2, 6-dimethylol phenol at different alkali concentrations. Temp.: 80° C.

Time in mins.	NaOH : 0·04 N 2, 6-dimethylol phenol m/l × 10^3	2, 6-dimethylol reacted m/l × 10^3	% of 2, 6-dimethylol reacted	NaOH : 0·006 N 2, 6-dimethylol phenol m/l × 10^3	2, 6-dimethylol reacted m/l × 10^3	% of 2, 6-dimethylol reacted
0·0	40·69	..	..	40·91	..	..
15	39·80	0·89	2·19	38·18	2·73	6·67
30	39·01	1·68	4·13	35·00	5·91	14·46
45	38·32	2·37	5·82	32·54	8·37	20·46
60	37·52	3·17	7·79	30·45	10·46	25·57
90	35·99	4·70	11·55	25·18	15·73	38·45
120	34·48	6·21	15·26	21·36	19·55	47·78
150	33·10	7·59	18·65	..	..	..
240	29·65	11·04	27·13	11·83	29·08	71·09

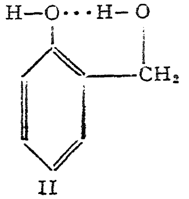
The rate of disappearance of saligenin was found to increase initially with increase in NaOH concentration from 0·003 to 0·006 N; but with further increase in alkali concentration, the rate began to decrease. The decreased reactivity of saligenin at higher alkali concentrations is apparent also in its condensation with phenol. Whereas 25% of saligenin reacted in an equimolar (0·04 M) saligenin-phenol reaction at 0·006 N NaOH in 4 hours, only 5% reacted in presence of 0·08 N NaOH during the same interval of time.[4] In the self-condensation of 2, 6-dimethylol phenol, its rate of disappearance is slower at 0·04 N NaOH than at 0·006 N NaOH.

With increase in NaOH concentration, the phenate ion concentration increases. In the phenate ion of the *ortho* methylol substituted phenols, a strong hydrogen bond is likely to be formed between the O⁻ and the CH_2OH and this makes the methylol phenol less free to react.

The presence of hydrogen bonds in the unionised form of saligenin as in I and II has

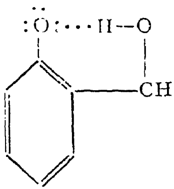


I

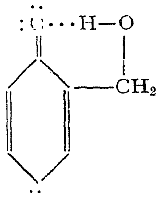


II

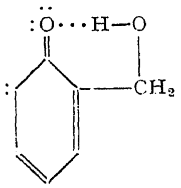
been demonstrated by Richards and Thompson[5] and Martin[6] from IR spectra. On the basis of the relative proton donor tendencies of the phenolic *versus* the alcoholic OH, Freedman[7] assigns I as the more probable structure. In the phenate ion, the only type of hydrogen bond is between the O⁻ and the CH_2OH as shown in III. Its resonance forms are shown



III



IV



V

in IV and V. Because of the strong electronegativity of the quinone oxygen, the hydrogen bond is likely to be much stronger than in the case of the unionised form. This makes the ionised form less reactive in condensation reactions than the less strongly-bonded methylol group in the unionised form.

Dept. of Chemistry, D. JOSEPH FRANCIS.*
Loyola College, L. M. YEDDANAPALLI.
Madras-34, *January* 20, 1969.

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* Present Address : Department of Chemistry, University of Kerala, Trivandrum.

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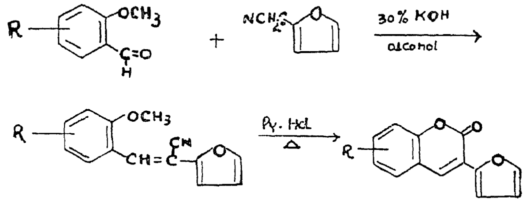
SYNTHESIS OF 3-(2-FURYL)-COUMARINS

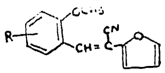
RAO *et al.*[1] have shown that a halogen in 7-position of coumarins contributed markedly to their fish-toxicity. Recently Wheeler *et al.*[2] observed that the introduction of a heterocyclic moiety in the 2-position of 6-chloro chromones, conferred anti-cancer properties on the molecule. Though 3-pyridyl,[3] 3-thienyl[4] and 3-thionaphthyl[5] coumarins have been reported earlier, the 3-(2-furyl) coumarins do not seem to have been synthesised so far. The present paper, therefore, deals with the synthesis of 3-(2-furyl)- and 3-(2-furyl)-4-methyl coumarins with hydroxy, halo, nitro and amino substituents in the benzenoid ring.

3-(2-furyl)-coumarins have been synthesised adopting the method of Buu-Hoi[4,5] while the modified method of Bargellini[6] by Seshadri[7] has been adopted for the synthesis of 3-(2-furyl)- and 3-(2-furyl)-4-methyl coumarins. The intermediate α-2-furyl-β-*o*-methoxy acrylonitriles required for the Buu-Hoi method have been obtained by condensing the appropriate *o*-methoxy benzaldehyde with 2-furyl acetonitrile[8] in the presence of a few drops of 30% aqueous potassium hydroxide or 20% aqueous sodium hydroxide. The acrylonitriles thus obtained were subsequently cyclised using pyridine hydrochloride.[9]



Adopting the above methods, compounds 1-7 (Table I) have been prepared. However, this method could not be applied for the preparation of compounds 9-14 (Table II) as the intermediate orthomethoxy benzaldehydes required could not be obtained in purity. Moreover, this method is not applicable to the synthesis of 4-methyl-3-(2-furyl) coumarins. So Bargellini procedure involving the condensation of sodium furylacetate with various substituted o-hydroxy acetophenones or o-hydroxy benzaldehydes in the presence of acetic anhydride

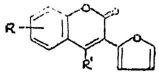
TABLE I



α-2-(Furyl)-β-o-methoxyphenyl acrylonitriles

Sl. No.			M.P. ° C.
1	2-Furyl	*o*-Methoxyphenyl	89
2	,,	5-Bromo-*o*-methoxyphenyl	118
3	,,	5-Chloro-*o*-methoxyphenyl	112
4	,,	3, 5-Dibromo-*o*-methoxyphenyl	136
5	,,	3, 5-Dichloro-*o*-methoxyphenyl	118
6	,,	2-Methoxy-1-naphthyl	108
7	,,	2, 4-Dimethoxyphenyl	116

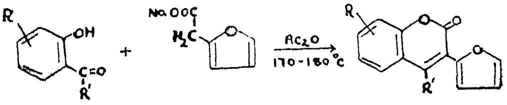
TABLE II



3-(2-*Furyl*)-*coumarins*

Sl. No.	Substituents R	Substituents R′	M.P. ° C.
1	..	H	83
2	6-Bromo	H	171
3	6-Chloro	H	150
4	6, 8-Dibromo	H	187
5	6, 8-Dichloro	H	174
6	5, 6-Dibenzo	H	219
7	7-Hydroxy	H	212
8	7-Methoxy	H	133
9	7-Acetoxy	H	168
10	6-Nitro	H	227
11	6-Nitro	CH_3	155
12	7-Acetoxy	CH_3	185
13	7-Acetamido	CH_3	280
14	7-Amino	CH_3	195

resulting in the formation of 3-(2-furyl)-4-methyl and 3-(2-furyl)-coumarins was adopted.



The compounds prepared have been listed in Tables I and II. The intermediate acrylonitriles (Table I) show a typical absorption around 2223 cm.$^{-1}$ assignable to $-C{\equiv}N$. In the cyclised products (Table II) the $-C{\equiv}N$ absorption is absent. Instead, they show a typical coumarin carbonyl absorption around 1725 cm.$^{-1}$

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Dept. of Chemistry, B. SREENIVASULU.
Osmania University, V. SUNDARA MURTHY.
Hyderabad-7 (A.P.), N. V. SUBBA RAO.
December 24, 1968.

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COMPARATIVE SENSITIVITY OF MOSQUITO CELL LINES, VERO CELL LINE AND INFANT MICE TO INFECTION WITH ARBOVIRUSES

THE establishment of cell lines from the larvæ of *Aedes albopictus* and *Aedes œgypti* in the absence of insect hæmolymph as a component of nutrient medium,[1] has given a new dimension to the work which can be carried out with the arthropod cells grown *in vitro*. Of special interest to us has been the response of these cells to infection with arboviruses. Initial studies[2,3] showed that (*i*) the *Aedes albopictus* cells (ATC-15) were more susceptible to infection with arboviruses than the *Aedes œgypti* cells (ATC-10); (*ii*) neither of the cell lines supported the growth of any of the tick transmitted arboviruses or of the non-arboviruses tested; (*iii*) only mosquito-borne arboviruses multiplied in the mosquito cell lines; and (*iv*) of the arboviruses which multiplied in these cell lines only those belonging to sero-group B of arboviruses produced cytopathic effect of *Aedes albopictus* cell cultures. The next step was to test the sensitivity of mosquito cell lines to infection with arboviruses, and to compare it with that of infant mice and VERO cell line.[4] Infant mice and VERO cells are routinely used in our laboratory for work with arboviruses.

The following mosquito-transmitted arboviruses were used in the study:—

Chikungunya (VRC No. 634029);
West Nile (VRC No. G 22886);
Japanese encephalitis (VRC No. P 20778);
Dengue 2 (VRC No. 673332);
Batai (VRC No. G 20217); and
Chandipura (VRC No. 653514).

Cultures of mosquito cell lines ATC-10 and ATC-15 and VERO cell lines were cultivated and maintained as reported earlier.[2] Litters of infant mice from the Virus Research Centre (VRC) colony of albino mice were used.

Viral strains diluted as serial tenfold dilutions in 0·75% bovalbumin in phosphate buffered saline were simultaneously inoculated in cultures of ATC-10, ATC-15 and VERO cells. 0·1 ml. per culture, four cultures per dilution.

Same series of dilutions were immediately afterwards inoculated intracerebrally in groups of infant mice, 0·02 ml. per mouse.

Sensitivity to viruses of various cell lines and infant mice was compared by calculating the minimum concentration of virus which produced infection in 50% of the inoculated cell cultures or mice. The end-points of viral infectivity were calculated as log 10 LD_{50}/0·1 ml. for mice and log 10 TCD_{50}/0·1 ml. for VERO cells. Since all of the viruses tested did not produce cytopathic effect in mosquito cell cultures, 50% end-points of infectivity (TCID_{50}) for ATC-10 and ATC-15 cells were calculated on the basis of detection of infectivity of the tissue culture fluids harvested from individual mosquito cell cultures on the seventh post-inoculation day. Infectivity of these tissue culture fluids was tested in VERO cultures, except in the case of dengue 2 virus where viral infectivity for both VERO cells and mosquito cells was detected by intracerebral inoculation in infant mice. In case of ATC-15 cultures infected with Japanese encephalitis, West Nile and dengue 2 viruses, 50% cytopathic end-points (TCD_{50}) were also calculated. These end-points corresponded exactly with the TCID_{50} end-points.

The figures in Table I give the results of these calculations expressed as reciprocals of the negative log 10 LD_{50}, TCD_{50} and TCID_{50} titres of various viruses in mice and different cell lines.

TABLE I

Comparative titres of selected arboviruses*

Virus	Infant mice	Cell lines		
		VERO	ATC-15 *Aedes albopictus*	ATC-10 *Aedes ægypti*
Chikungunya	8·2*	8·17	8·25	
		8·3	8·66	6·6
West Nile ..	8·6	9·0	9·0†	7·0
Japanese encephalitis	8·4	9·0	9·5†	Not susceptible
Dengue 2 ..	6·9	6·5	8·5†	,,
Batai ..	7·2	6·83	6·0	,,
Chandipura ..	9·5	9·3	9·0	7·66

* Expressed as the LD_{50}, TCID_{50} or TCD_{50} reciprocal of the negative Log 10. † Cytopathic end-points (TCD_{50}) of these viruses corresponded to their infective end-points (TCID_{50}) given in Table I.

These results show that ATC-10 cell line which has previously been shown to support the growth of only selected viruses, is much less sensitive to infection with arboviruses than ATC-15 cell line.

ATC-15 cell line is equally or slightly more sensitive to infection with Chikungunya, West Nile and Japanese encephalitis viruses as compared to infant mice and VERO cells. It is slightly less sensitive than mice and VERO cells to infection with Batai and Chandipura viruses. However, it is 100 times more sensitive than VERO cells and 40 times more sensitive than infant mice to infection with dengue 2 virus strain used in this study.

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Virus Research Centre,* SHARDA DEVI PAUL.
Poona, India, K. R. P. SINGH.
December 26, 1968.

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STUDIES IN SCHIFF'S BASES

THE reaction of aldehydes with amines to give schiff's bases is well known. A number of workers have carried out these condensations with a view to synthesise new schiff's bases.[1-4] In recent years, the metal complexes of schiff's bases have also attracted the attention of many workers.[5] In this communication a few hitherto unknown schiff's bases, which were prepared to investigate the preparation, properties and structure of their metallic complexes, are being reported.

In the present work, schiff's bases have been prepared by the condensation of *m*-aminophenol with various aromatic aldehydes. The following is a typical example.

0·01 mole of *m*-aminophenol and 0·01 mole of veratric aldehyde were mixed together in 25 ml. pure ethanol (aldehyde free) and refluxed in a water-bath for about two hours. The reaction mixture was poured into crushed ice. The compound obtained was filtered and recrystallized from rectified spirit or alcohol-water mixture. The condensations with other aldehydes were also carried out in a similar way and the results are given in Table I.

TABLE I

Preparation of various schiff's bases by condensation of m-aminophenol with different aldehydes

	Name of the compound	Yield (%)	Refluxing time (hr.)	Colour of product	Melting point (°C.)	% of Nitrogen	
						Found	Calculated
(*a*)	3, 4-methoxy benzylidine-*m*-hydroxy aniline	55·6	2	Buff	73– 74	5·60	5·46
(*b*)	3-methoxy-4-hydroxy benzylidene-*m*-hydroxy aniline	61·3	1	Brownish-yellow	131–132	5·54	5·64
(*c*)	Salicylidene-*m*-hydroxy aniline	82·2	1½	Orange-yellow	122–123	7·0	6·6
(*d*)	Anisylidene-*m*-hydroxy aniline	70·5	1½	Grey	95– 96	5·28	5·27
(*e*)	*p*-methylbenzylidine-*m*-hydroxy aniline	52·1	1½	Light brown	197	6·34	6·56
(*f*)	*p*-nitrobenzylidene-*m*-hydroxy aniline	49·6	1½	Yellowish-brown	199–201	6·59	6·00
(*g*)	2-hydroxy naphthylidene-*m*-hydroxy aniline	30·4	1½	Deep yellow	228	7·80	7·0
(*h*)	Benzylidene-*m*-hydroxy aniline	50·8	2	Brownish	101–102	9·82	10·05
(*i*)	*p*-dimethylamino benzylidene-*m*-hydroxy aniline	45·4	2	Buff	196–198	..	..

We wish to thank Professors C. N. R. Rao and M. V. George for their kind interest in the work.

Dept. of Chemistry,
Indian Institute of
Technology,
Kanpur, *December* 31, 1968.

S. S. KATIYAR.*
K. B. RAUT.‡
P. A. ARVINDAKSHAN.

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* To whom all the correspondence should be addressed.

‡ Present Address: Department of Chemistry, Savannah State College, Savannah, Georgia (U.S.A.).

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PLAGIOCLASE FELSPARS OF THE JAMKHANDI GRANITES AND THEIR GENETIC SIGNIFICANCE

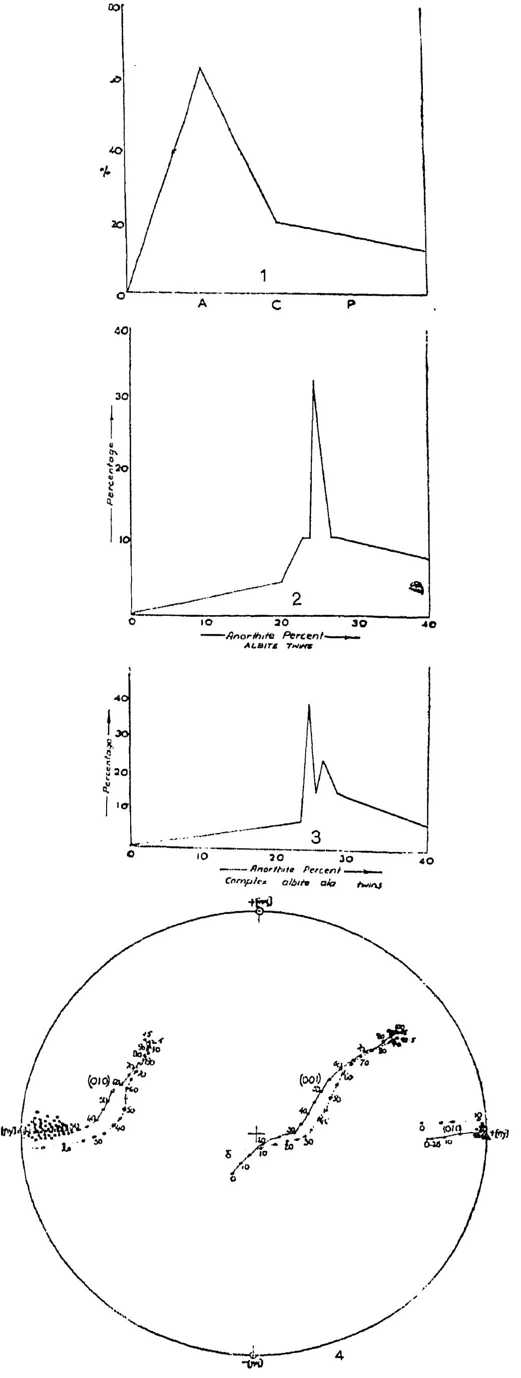
PLAGIOCLASE felspars from the granites exposed around Jamkhandi (Lat. 16° 30′; Long. 75° 15′) were selected for detailed investigation of their optical properties. About 60 grains in 14 thin sections representing different granitic outcrops of the area were studied on Fedorov's 4-axes universal stage (P. R. J. Naidu, 1958) for the determination of anorthite content and twin laws according to the methods of Reinhard. Such plagioclases constitute about 37% of the granite and have developed good polysynthetic twinning. They are optically negative with $-2\,V = 83^\circ$-88° and $Z \wedge c = 83^\circ$-85°. Their anorthite content ranges between 20% and 30% and the composition face runs parallel to 010. Thus the plagioclase felspars correspond to oligoclase. The transferred poles of the composition face when superposed on tafel 2 of Reinhard tend to cluster between 20% and 30% anorthite content on 010 curve, and show very little dispersion.

Majority of the plagioclase felspars have been twinned after the albite law while a few are after the complex albite ala law. In addition to these there are also the combined-albite-pericline twins. The other usual twins like the manebach, acline, manebach-acline, and baveno are practically absent. Both the simple and complex laws were checked by Nikitin's and Berek's constructions. The frequency percentages of different types of twins supplemented by a graph (Fig. 1) is tabulated below. The data show that the albite twins are the most abundant.

TABLE I

Twin law		Per cent
Albite	..	63
Complex albite ala	..	20
Combined albite-pericline	..	17
		100

Statistical studies of each type of twinning bring out that majority of the albite twins are present at 25% An while they are least recorded



FIGS. 1-4. Fig. 1. Percentage frequency of different types of plagioclase twins in the Jamkhandi granites. A = Albite twins; C = Complex albite ala twins; P = Complex albite pericline twins. Fig. 4. Cumulative diagram where the anorthite content of 60 plagioclase felspar grains are plotted. ——— Low temperature series. – – – – High temperature series.

at 20% An (Fig. 2). Similarly the complex albite ala twins occur abundantly at 24% An while they are less abundant at 23% An (Fig. 3). The pericline twins occur at all percentages ranging from 20% to 30% An.

The transferred poles of the composition face along with the different optical ellipsoids when superposed on plate IX of Burri, Parker and Wenk[1] fall at 20-28% An on 010 curve of the low temperature series thus suggesting that the felspars of the Jamkhandi granites belong to low temperature series (Fig. 4).

Many petrographers like Gorai[2] and Turner[3] have worked on the morphological and genetical aspects of plagioclase felspars and have distinguished igneous and metamorphic granites depending on the plagioclase twinning. Vance[4] and Smith[5] have differentiated the primary and secondary twinning in plagioclase felspars and have also described the characteristic features of such twins.

The plagioclase felspars of the granites under investigation exhibit well-developed polysynthetic twinning wherein the lamellæ are thin and regular, being invariably identical with the neighbouring lamellæ. They often follow the bending or fracturing which the grain has suffered and sometimes are slightly oblique to the composition plane. Such features suggest that they are glide twins, a type of secondary twinning (Vance[4]). The formation of such secondary twinning appears to be due to stress on plagioclase felspar,[4,5] which is indicated by the evidences of cataclasm like brecciation and granulation of the component minerals of granite. Further it is observed that majority of the twin lamellæ are homogeneous in nature which shows that the strain imposed was uniform and simultaneous, thus resulting in types of similar twinning in the plagioclase felspars.

Coulson[6] observed that the 33% anorthite of plagioclase seems to be favourable for the formation of complex albite ala twins. In the present study, however, complex albite ala twins are fairly common in the plagioclases of 20-28% An content thus indicating that such twins can also occur at a lesser percentage than 33% An. Such twinning frequencies have also been recorded for similar plagioclase felspars of the granites and gneisses of Jalarpet,[7] the granites of Mysore State,[8] the Clospet granite[9] and the granites and gneisses of Shirahatti area.[10]

The statistical studies of twin laws of plagioclase felspars also show the predominance of

A-twins (80%) over C-twins (20%) which is a characteristic feature of metamorphic rocks.[2] Thus based on the above data, the Jamkhandi granites can be grouped under M-granites.

Vance[4] has observed that the frequency of the twinning depends on the grain size of the rock as well as the degree of interlocking of the constituent plagioclase grains. Viewed in this background, the granites under study also exhibit an inequigranular and coarse-grained texture with abundant twinned plagioclase felspars. Predominance of twinned plagioclase grains with a few sub-individuals, and twinned according to one law is suggestive of a metamorphic origin.[5] The fact that the Jamkhandi granites belong to the low temperature series further indicates that they are metamorphic in origin as the metamorphic temperatures are generally lower than the magmatic temperatures[8] and the uniform composition of the plagioclase felspar grains also suggests prevalence of similar environmental conditions at the time of their formation.

The authors are thankful to Prof. M. N. Viswanathiah for encouragement.

Dept. of Geology, B. V. Govinda Rajulu.
University of Mysore, H. R. Nagaraja.
Manasa Gangotri, Mysore-6,
December 11, 1968.

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SOME OBSERVATIONS ON THE FIBRE PATTERN IN THE LEG MUSCLE OF TWO SPECIES OF COCKROACHES, *BLATELLA GERMANICA* AND *PERIPLANETA AUSTRALASIAE*

I HAVE read with considerable interest the two articles which appeared recently in *Current Science*, one by Bhat[1] and the other by George[2] regarding the occurrence of some specialised fibres amidst the ordinary ones, in the wing muscles of the dragon-fly *Pantala flavescens*.

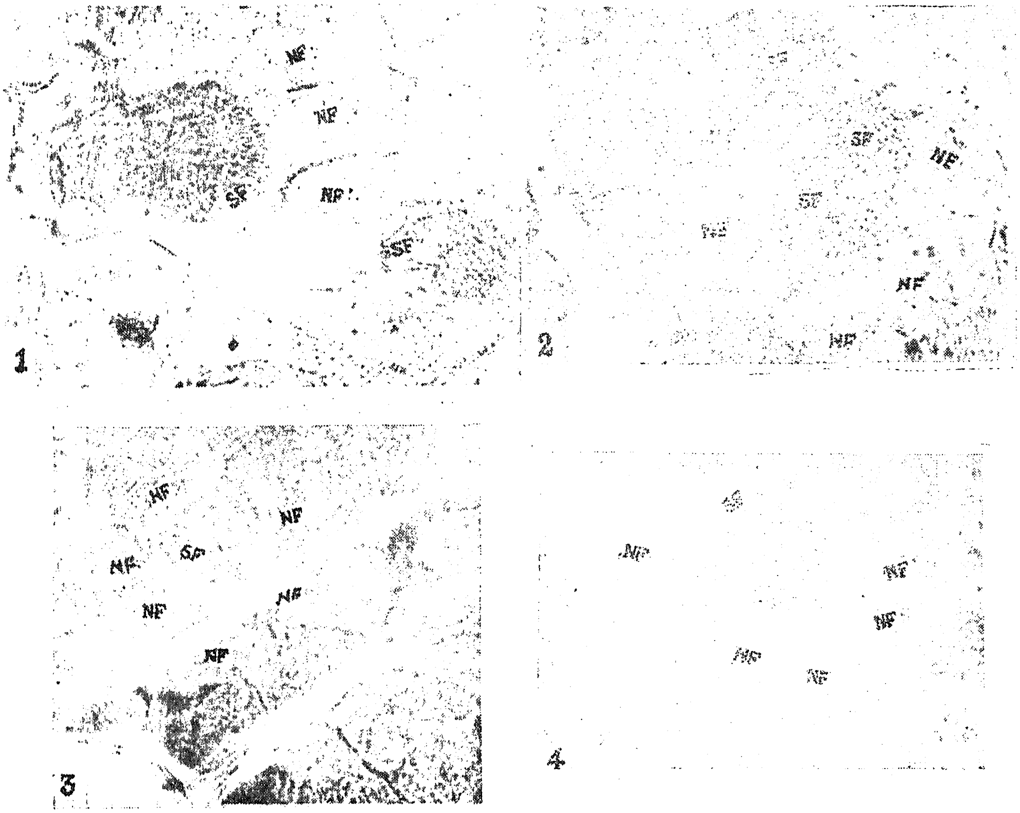
In my own studies on the cellular organization in insect muscles, I have come across similar specialised fibres in the leg muscles of the two cockroaches, *Blatella germanica* and *Periplaneta australasiœ.*

The adult cockroaches used in the present observations were collected from the fields. They were killed by severing the head, after which the metathoracic leg muscles were carefully removed and sections were taken on the freezing microtome for observations with respect to fibre diameter, as well as fat, lipase and succinic dehydrogenase (S.D.H.) contents. Fresh frozen sections mounted in glycerine were used for determining the fibre diameter. Fat content was histochemically assessed by sudan black B method. The Tween method of Gomori (Pearse[4]) using "Tween 80" as substrate was employed to detect lipase. Histochemical localisation of S.D.H. was ascertained by using Nitro-BT as a hydrogen acceptor (Pearse[4]).

Histologically the leg muscle fibres in these two species of cockroaches are for the most part ordinary ones, but a few fibres occurring in the periphery of the muscle bundle are of the specialised type. The diameter of these specialised fibres varies from 30 to 73 microns in both the species, whereas that of the ordinary ones varies only from 19 to 40 microns. The preliminary studies of their cytochemistry have shown that the specialised fibres stained intensively for fat and the enzymes, lipase and S.D.H. compared to the normal fibres. The mitochondria in the specialised fibres appear to be bigger than those in the ordinary ones.

Bhat[1] characterises the specialised fibres met with in the wing muscles of *Pantala flavescens* as hypertrophied and is of the opinion that "Muscle hypertrophy generally results from continuous and prolonged exercise of the organ to cope up with high energy demand". In contrast, George[2] states that "The occurrence of the two types of fibre is, therefore, to be regarded as a case of cellular specialization which may reflect hypertrophy of certain structures within the cell which are less evident in other cells and also represent different metabolic and functional adaptations". He further states that "It could, therefore, be argued that *Pantala flavescens* in having the Type 2 fibres in their flight muscles is capable of a certain amount of manœuvrability in flight". The cockroaches *Blatella germanica* and *Periplaneta australasiœ* take only occasionally to flight. Neither the leg nor the flight muscles of the following insects which I have so far examined show such specialised fibres: (1) *Periplaneta americana*, the common house cockroach; (2) *Cybister confusus*, a vigorously swimming dytiscid beetle; (3) *Ranatra elongata*, a nepid bug; (4) the orthopterans *Atractomorpha crenulata* and *Cyrtacanthacris ranacea* which are actively jumping grasshoppers.

As George[2] has correctly opined, intracellular structures in such specialised fibres seem to have undergone structural hypertrophy with concomitant biochemical changes. It should be of interest to mention here that Nene and George[3] have reported the occurrence of a third type of fibre, large red containing high concentrations of fat, lipase and succinic dehydrogenase, in the avian supinator muscle. These specialised leg muscle fibres in these two species of cockroaches seem to be comparable to the third type fibres of the avian supinator muscle.



FIGS. 1–4. Photomicrographs of the transverse section of leg muscles showing the muscle fibre pattern in the two species of cockroaches, *Blatella germanica* and *Periplaneta australasiæ*. Fig. 1. Leg muscle fibres of *Blatella germanica* stained for fat, × 430. Fig. 2. Leg muscle fibres of *Blatella germanica* stained for lipase activity, × 430. Fig. 3. Leg muscle fibres of *Blatella germanica* stained for S.D.H. activity, × 430. Fig. 4. Leg muscle fibres of *Periplaneta australasiæ* stained for S.D.H. activity, × 430. SF, Specialised fibres; NF, Normal fibres.

I am grateful to Dr. C. J. George for his guidance, and to the U.G.C. for the award of a Research Scholarship.

Dept. of Zoology, V. L. KALLAPUR.
Karnatak University,
Dharwar-3, *January* 16, 1969.

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THE EFFECT OF HETEROSIS ON PROTEIN CONTENT IN PEARL MILLET

RECENTLY, there has been considerable interest in the breeding and improvement of pearl millet (*Pennisetum typhoides* Burm. S. & H.). With the exploitation of male-sterility and the introduction of hybrid seeds,[1] a break-through has been achieved in the grain production. However, limited attention has been paid to the improvement of grain quality. As protein is the most important factor for quality determination, the effect of heterosis on the protein content needs to be evaluated. Therefore, the present studies were taken up.

Six inbred lines belonging to different eco-geographic regions, three Indian (SG-31, BIL-1 and BIL-3 B); two African (PAG-38 and Ghana-73); and one American (Tf. 18 B), were crossed in all possible one-way combinations. The experiment comprising the parental and F_1 lines was laid out in randomised block design with three replications. The grain yield and protein content were recorded on plot basis. Protein content was determined by the method suggested by McKenzie and Wallace.[3] For convenience, the inbreds SG-31, PAG-38, Ghana-73, Tf. 18 B, BIL-1 and BIL-3 B have been designated as A, B, C, D, E and F respectively in Tables I and II.

The grain yield and protein content of the parents are presented in Table I. The F_1 and mid-parental values as also the increase/decrease of F_1 over the mid-parentals for grain yield and protein content are set out in Table II. It is evident from the results that all the crosses surpassed the mid-parental values for grain yield by a considerable margin, the increase of F_1's over the mid-parental value ranged from as high as 104% to 896%. However, in case of protein content the F_1 value was less than the mean of the parents in all the crosses. The results for protein content appear to be contrary to those obtained by Mahadevappa,[2] who has also not mentioned heterosis for grain yield. The anomaly in the two results could be due to the differences in the genetic make-up of the inbred lines involved.

In the breeding programmes aimed at the production of high-yielding hybrids in pearl millet, it is, therefore, important that the protein content is given careful consideration, in view of the fact that the considerable amount of heterosis for grain yield is always accompanied by a reduction in protein content.

TABLE I

Mean values of six inbred lines for grain yield and protein content

Character	SG-31 (A)	PAG-38 (B)	Ghana-73 (C)	Tf.18B (D)	BIL-1 (E)	BIL-3B (F)
Grain yield ..	10·09	5·97	13·59	19·89	19·39	10·43
Protein content	15·68	12·31	14·17	17·53	11·54	9·84

TABLE II

The F_1, mean, mid-parental values, increase/decrease over the MP for grain yield and protein content and the protein yield per plot (grain yield × protein content)

	Grain yield			Protein content			
Cross	F_1	MP*	% increase over MP	F_1	MP	% decrease over MP	(Grain yield × protein content)
A×B	58·33	8·03	627	12·96	13·99	7·4	756
A×C	53·27	11·84	350	12·76	14·94	14·9	678
A×D	30·52	14·99	104	15·46	16·65	7·2	472
A×E	52·88	14·74	259	11·74	13·61	13·7	621
A×F	86·30	10·26	741	11·92	12·76	6·6	1021
B×C	53·95	9·78	452	12·34	13·24	6·8	666
B×D	99·39	12·93	668	9·41	14·92	36·9	935
B×E	70·01	12·63	454	9·61	11·92	19·4	673
B×F	81·65	8·20	896	8·52	11·07	42·8	696
C×D	67·54	16·79	302	11·11	11·07	42·8	750
C×E	58·75	16·49	256	11·49	12·85	11·3	670
C×F	57·95	12·01	383	10·28	12·00	14·3	596
D×E	88·88	19·64	353	9·29	14·53	36·1	826
D×F	116·64	15·16	669	10·60	13·68	22·5	1236
E×F	76·77	14·91	415	9·54	10·69	10·8	732

* MP = Mid-parental value.

Dept. of Plant Breeding,
Punjab Agric. University,
Ludhiana, *January* 18, 1969.

P. S. Phul.
N. D. Rana.
A. K. Goswami.

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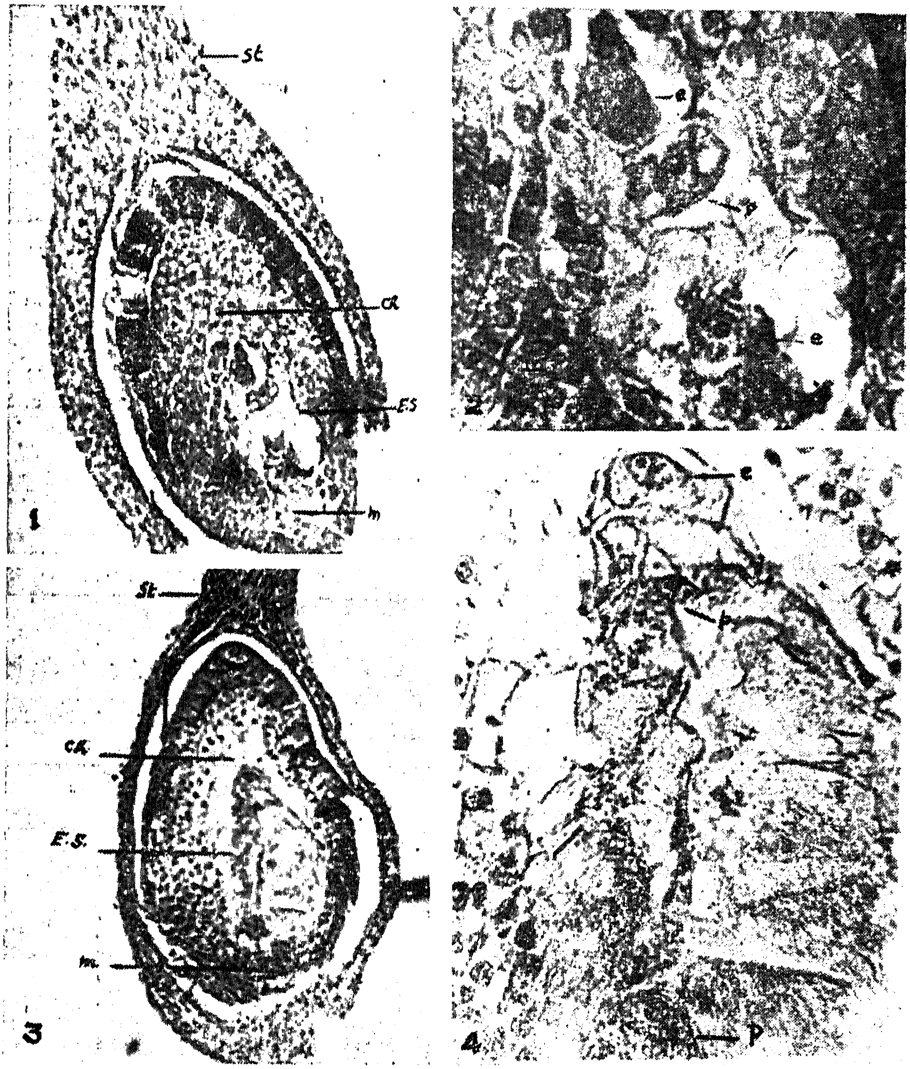
A NOTE ON TWIN MEGASPORES AND ABNORMAL EMBRYO-SAC IN *SACCHARUM**

Fertilization studies were undertaken in the intergeneric hybridization of *Saccharum* with *Zea mays*. The spikelets were fixed in formalin, acetic acid and alcohol (1 : 1 : 18) at 6, 10, 22, 24, 32 and 48 hours after pollination. The ovaries were dissected out along with styles and embedded in paraffin and microtomed at 12 μ thickness. The sections were



Figs. 1-4. Fig. 1. L.S. of ovary in the cross I.A. 1384 × autotetraploid maize, showing embryo-sac, × 100. Fig. 2. Closer view of Fig. 1 showing the twin eggs and the fused polar cell, × 430. Fig. 3. L.S. of ovary in the cross Co. 419 × diploid maize showing the embryo-sac, × 100. Fig. 4. Closer view of Fig. 3 showing the normal binucleate polar cells (the egg cell has been cut during microtomy) and the pseudo embryo-sac at the chalazal end, × 430. *ch*—chalazal end; *E.S.*—embryo-sac; *e*—egg cell; *m*—micropylar end; *p*—polar cell; *st*—style.

stained in Heidenhain's iron hæmatoxylin for 30 minutes and mounted in Euprol.

In the normal mature embryo-sac, the egg-cell and the two pear-shaped synergids are situated towards the micropylar end, with the 2 polar nuclei or the fused polar nucleus above the egg, while the antipodal complex is towards the chalazal end. In the cross I.A. 1384 × autotetraploid maize ($4n = 40$) at 22 hours after pollination, enlarged egg with denser cytoplasm was noticed at the micropylar end and fused polar nucleus above the egg. At the chalazal end one of the antipodal cells was also enlarged and had denser cytoplasm and resembled the egg-cell. The other two antipodals had degenerated (Figs. 1-2). The reason for the occurrence of twin eggs may be due to one of the antipodal cells being stimulated by the foreign pollen to develop into an egg-cell in addition to the normal egg. In *Synedrella nodiflora* Gaertn, belonging to the tribe Heliantheæ, Sundara Rajan[2] has observed two megaspores (*i.e.*, chalazal and micropylar) in a tetrad developing and the middle two degenerating. Dutt and Subba Rao[1] have noticed an abnormal embryo-sac in the cross of sugarcane varieties, *viz.*, Vellai × C.A.C. 87 in which the antipodal cells were situated towards the micropyle and the egg and polars towards chalaza. In the cross Co. 419 × diploid maize ($2n = 20$) at 48 hours after pollination an abnormal embryo-sac was observed. The prominent binucleate polar cells were found at the micropylar end. At 48 hours usually the antipodals degenerate. But in this embryo-sac, a conspicuous egg at the chalazal end and below that two crescent-shaped polar cells were noticed (Figs. 3-4). The binucleate condition of polar cells suggests that fertilization had not occurred. So in this case the germination of foreign pollen might have influenced the 3 antipodals to form into a pseudo embryo-sac.

I am grateful to Dr. D. Jagathesan, Cytogeneticist, for the guidance and encouragement.

Sugarcane Breeding Inst., L. D. VIJENDRA DAS.
Coimbatore, *January* 6, 1969.

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* Approved for Publication by Director, Sugarcane Breeding Institute, Coimbatore.

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GROWTH REGULATORS INDUCED PARTHENOCARPY IN MANGO (*MANGIFERA INDICA* L.)

THE involvement of naturally-occurring plant growth hormones such as auxins, gibberellins and kinins in the growth and development of fruits has been demonstrated by a number of experiments.[1-3] Since application of auxin alone could not induce fruit development in mango,[6] attempts were made in the present study conducted during 1967, to develop parthenocarpic fruits in Dashehari mango using three groups of plant growth regulators, namely, auxin, gibberellin and kinin.

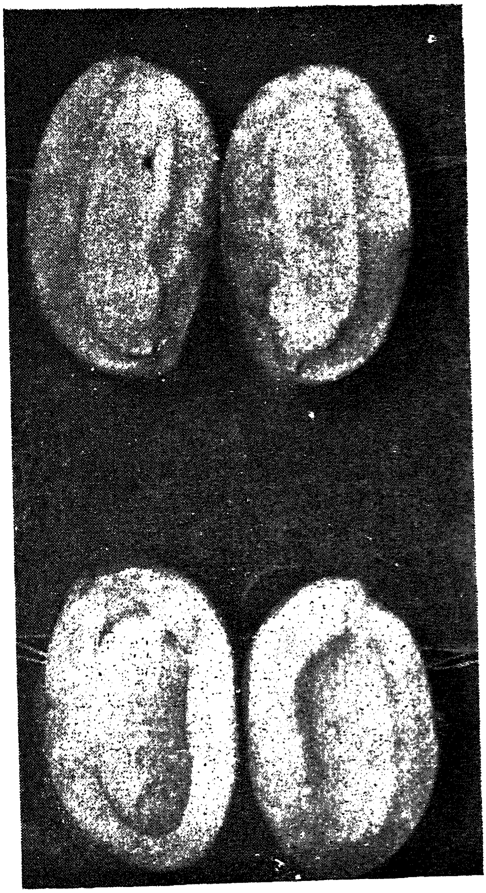

FIG. 1. Above—Parthenocarpic fruit cut open, showing pinpoint ovule and development of endocarp. Below—Normal fruit with fully developed seed and endocarp.

The self-incompatible variety Dashehari was selected for this study. Three chemicals, namely, N^6-benzyladenine (250 ppm), beta-naphthoxy-acetic acid (10 ppm) and gibberellic acid

(250 ppm) either alone or in various combinations were sprayed on the bagged panicles. Control panicles were sprayed with only distilled water. However, parthenocarpic fruits developed upto maturity only in panicles treated at fully opened stage with a combination of 250 ppm N^6-benzyladenine and 10 ppm beta-naphthoxyacetic acid *plus* 250 ppm gibberellic acid. The treatment was given at fortnightly intervals till the fruits were half-grown.

Longitudinal cutting of the full-grown parthenocarpic fruits showed the presence of undeveloped ovule which had the size of a pin head (Fig. 1). The seedless fruits were much smaller in size and weighed only 65 gm. at maturity as against the average weight of 165 gm. of normal fruits. Also, the development of the stony endocarp in the seedless fruit was normal as in seeded fruits. However, only the degenerated ovule was present inside the stone enclosed by a thin papery white seed-coat. The pulp/stone ratio was much higher in the parthenocarpic fruits (15 : 25) than in the normal fruit (5 : 6).

The present preliminary findings thus show that fruit set and growth without pollination and fertilization is possible in mango, provided that the ovaries are given sufficient supply of kinin, auxin and gibberellin by external application.

Thanks are due to Dr. S. K. Mukherjee for providing facilities and encouragement and to Dr. Van Overbeek (Shell Research, Ltd., U.S.A., for gifting a sample of N^6-benzyladenine. The technical help rendered by Dr. C. P. A. Iyer and Dr. (Mrs.) Raj Kachroo during the fieldwork is gratefully acknowledged.

Div. of Horticulture, E. K. CHACKO.*
Indian Agric. Res. Inst., R. N. SINGH.
New Delhi-12, *December* 30, 1968.

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* Present address: Institute of Horticultural Research 255, Upper Palace Orchard, Bangalore-6.

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DETECTION OF GROWTH REGULATORS IN THE GALLS OF *SALVADORA PERSICA* LINN.

THERE are a number of reports about the occurrence of inhibitors in fruits and seeds (Evenari, 1949). Hardly any report pertaining to growth-promoting substances in plants exists in literature. Sircar *et al.* (1959, 1960) have reported growth-regulating properties in the root extract of water hyacinth. Kathju *et al.* (1969) have noticed growth inhibitors in different parts of *Salvadora persica*, except for the aqueous extract of dry stem which promoted the growth of *Cyamopsis tetragonoloba*. The present note reports the detection of a growth-promoter in the galls of *Salvadora persica* which commonly form tumourous growths in almost any part of the plant (Fig. 1).

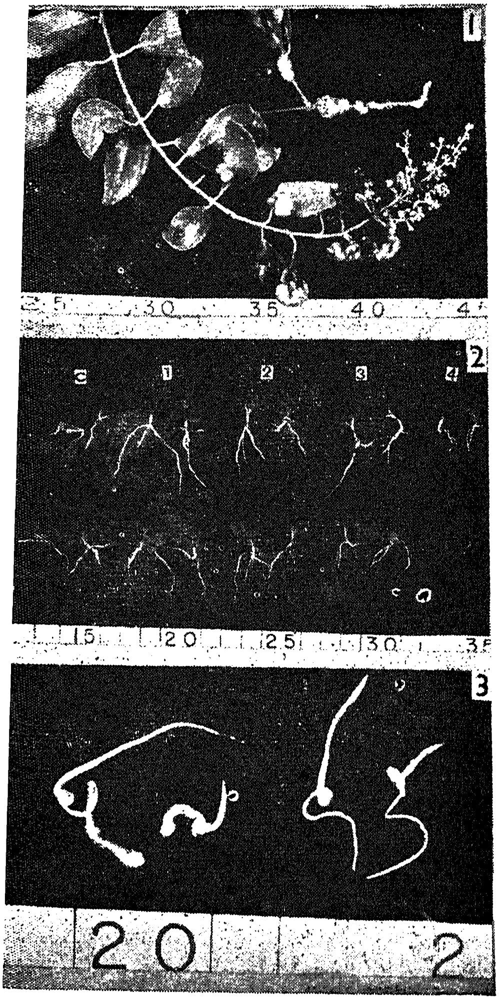
Salvadora persica is a common desert tree. Extract from the galls were prepared and diluted accordingly in distilled water. Part of the extract was autoclaved (15 lb. pressure for half-an-hour) and a part was kept as such. Seeds of *Asteracantha longifolia* were germinated and the seedlings were grown in different concentrations of the extract (1%, 2·5%, 5% and 10%) both unautoclaved and autoclaved separately. There has been almost no effect on germination of seeds but the growth was remarkably affected. The results of this have been incorporated in Table I.

TABLE I

Effect of different concentrations of unautoclaved and autoclaved extracts from the galls of Salvadora persica *on the seedling growth of* Asteracantha longifolia *(seedlings five-days-old)*

Concentration of extracts	Unautoclaved extract		Autoclaved extract	
	Radicle in mm.	Hypocotyl in mm.	Radicle in mm.	Hypocotyl in mm.
Control	19·3±5·4	13·3±1·1	25·4± 5·1	14·2±1·9
1 per cent	28·7±4·8	18·0±1·9	35·3±11·6	20·2±4·7
2·5 ,,	33·2±7·0	22·6±5·0	28·6± 5·0	21·4±4·1
5 ,,	24·6±5·6	18·8±3·5	26·1± 4·2	23·0±3·3
10 ,	12·0±5·0	11·2±3·6	18·0± 7·1	16·0±3·6

It would be evident from Table I that radicle as well as hypocotyl of *A. longifolia* were affected beneficially in both unautoclaved and autoclaved extracts from the galls of *S. persica*. In unautoclaved extracts the best radicle growth took place in 2·5% whereas in autoclaved one it was so in 1% extract, thus indithat growth-promoting principle was effective in dilute solution. The growth- ing substance was thermostable whereas hibiting one became ineffective after ving, indicating its thermolabile nature. oclaved extracts of 2·5% and the auto- of 5% concentration exhibited the best ting effect on hypocotyl growth. In aved extracts some promotion of hypocotyl was observed upto 10% concentration (Fig. 2).



IGS. 1–3. Fig. 1. *Salvadora persica* branch showing nature of galls. Fig. 2. Effect of aqueous extract n autoclaved (A) and unautoclaved (U) from the galls *Salvadora persica* on the growth of *Asteracantha zfolia* seedlings after five days in different concentra-s C=Control; 1=1%, 2=2·5%, 3=5%; and 4= 5. Fig. 3. Profuse root-hair formation in three days seedlings of *Pennisetum typhoideum* uncontaminated aqueous extract from the galls of *Salvadora persica* t) and the one in contact with extract having fewer t-hair (right).

. The effect of growth-promoting substance was also observed when new roots were initiated in decapitated hypocotyl at the hypocotyl/radicle transition region. The effect of root-promotion differed according to the concentrations of the extract, but they were better in dilute solutions. Root-hair formation was profuse when extract did not come in contact with root as compared to the one where it remained dipped in the extract (Fig. 3).

Discovery of growth-promoters in the desert plants would help much in the afforestation purposes and also in the improvement of desert. The dominance of some definite growth-promoting substance in the present report is noteworthy. The Rf value of the growth-promoter for shoot was found to be 0·5. The chemical properties and other physiological effects with other known growth-promoters are yet to be analysed.

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RESPONSE OF INOCULATED AND UNINOCULATED LEGUMES TO APPLICATION OF PHOSPHATE

THAT the legumes respond to application of phosphates[1] and most often to inoculation with cultures of respective *Rhizobium* species[2] is well known. It is not known, however, if inoculation increases uptake of phosphates from the soil as will be required for increased growth. During the present studies, a pot culture experiment was carried out with three legumes, cowpea (*Vigna sinensis*), mung (*Phaseolus aureous*) and urid (*Phaseolus mungo*) treated with dicalcium phosphate tagged with radioactive P^{32} at the rate of 80 kg. of P_2O_5 per hectare. The cultures for inoculation were obtained from the Culture Collection of the Division of Microbiology. The crops were harvested after 6 weeks. Phosphate content of the plants was estimated by Vanadomolybdate method.[3] Radiophosphorus in the digested plant material was determined as described by Mackenzie and Dean.[4] G.M. counter with binary scaler was used for recording the data. The radio-assay data were utilised to calculate the uptake of fertilizer and soil phosphate.

The total dry yield, total phosphate uptake and uptake of fertilizer and soil phosphate are given in Table I.

TABLE I

Uptake of phosphorus from the soil and dicalcium phosphate by inoculated and uninoculated legumes

(The figures quoted in Table I are average of 4 replications.)

Treatments		Total dry matter yield (g.) pot	Total phosphate in plant (mg.)	Uptake of phosphorus from	
				Fertilizer (mg.)	Soil (mg.)
Cowpea (*Vigna sinensis*)					
Uninoculated	..	5·65	8·77	0·158	9·41
Inoculated	..	6·95	11·91	0·223	11·27
C.D. at 5%	..	1·04	1·52	N.S.	2·27
Mung (*Phaseolus aureons*)					
Uninoculated	..	4·60	5·39	0·076	4·98
Inoculated	..	5·38	7·19	0·104	8·93
C.D. at 5%	..	0·52	1·62	N.S.	N.S.
Urid (*Phaseolus mungo*)					
Uninoculated	..	4·98	6·72	0·101	6·57
Inoculated	..	5·55	7·99	0·145	9·15
C.D at 5%	..	N.S.	N.S.	N.S.	N.S.

N.S.—Not significant.

A scrutiny of the data will show that the yields and uptake of phosphorus in the case of all the three legumes when considered together and statistically analysed would indicate that inoculation would give rise to higher yields of dry matter, total uptake of phosphates and higher uptake of phosphate from the soil.

Division of Microbiology, V. ISWARAN.
Indian Agric. Res. Inst., S. K. KAVIMANDAN.
New Delhi-12, M. B. KAMATH.
January 20, 1969.

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CHEMICAL RADIATION DAMAGE IN CRYSTALLINE AMMONIUM DICHROMATE

MOHANTY and co-workers[1] have studied annealing of chemical radiation damage in a variety of solid substances. We have now investigated ammonium dichromate in our search for newer systems susceptible to annealing.

AR grade ammonium dichromate was sieved to obtain crystals in the 150–200 mesh range. The crystals were dried over phosphorus pentoxide and irradiated with 2 Mev electrons from a Van de Graaff machine to a dose of 50 Mrad with the samples so distributed that their thickness in the direction of the beam was less than half the range of the electrons in the material. At each pass under the beam a dose of about 1 Mrad was delivered. Irradiations were interrupted periodically so that the temperature of the irradiated material was always below 45° C. The damage Cr(III) was separated[2] from the target, along with Al as carrier, by precipitating it as the phosphate at pH 5–5·4. The phosphate, purified by two reprecipitations with washing, was dissolved in 0·5 N sulphuric acid and the Cr(III) oxidized with a slight excess of potassium permanganate. The excess permanganate was destroyed with just the necessary amount of sodium azide. The solution was adjusted to 0·2 N with respect to sulphuric acid and the colour developed with alcoholic diphenylcarbazide was determined spectrophotometrically at 540 mμ.

The damage induced in the substance by the irradiation was 1839 ppm Cr(III). Heating at temperatures up to 125° C. for 25 hours did not bring about any recovery of the damage. On the other hand, Getoff and Maddock[3] have observed sensible recovery of the (n, γ) recoil damage in the substance even on heating at as low a temperature as 104° C.

Nuclear and Physical S. R. MOHANTY.
Chemistry Lab., (MISS) S. RAY CHAUDHURI.
Dept. of Chemistry,
Utkal University,
Bhubaneswar-4, *January* 27, 1969.

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REVIEWS AND NOTICES OF BOOKS

Annual Review of Physical Chemistry (Volume 19). Edited by Henry Eyring. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. 645. Price: U.S.A. $ 8.50; Elsewhere $ 9.00.

This volume under review contains 20 chapters. A survey of chapter headings reveals a diversity in physical chemistry that bears out G. N. Lewis' description of the field as everything that is interesting.

The titles of the chapters contained in this volume are: Fifty Years of Soviet Physical Chemistry; Electron Paramagnetic Resonance; Fused Salts; Electrochemistry; Experimental Inorganic Thermochemistry; Fast Reactions in Solution; Radiationless Molecular Electronic Transitions; Ligant Substitution Dynamics; Vibrational and Rotational Relaxation; Surface Chemistry; Ion-Molecule Reactions; Mass Spectrometry; Lasers and Their Applications to Physical Chemistry; Gas Reactions Yielding Electronically Excited Species; Statistical Mehanics—A Review of Selected Rigorous Results; Vibrational Spectroscopy; Nuclear Magnetic Resonance; Optical Rotation; Physical Organic Chemistry; Quantitative Conformational Analysis; Calculation Methods; and He^3-He^4 solutions. C. V. R.

Selective Toxicity (Fourth Edition.) By Adrien Albert. (Methuen & Co., Ltd., 11, New Fetter Lane, London E.C. 4), 1968. Pp. xvii + 531. Price 90 *sh*.

This book deals with selectively toxic agents, particularly the physical and chemical properties that are responsible for their selectivity. By selectivity is meant the property of injuring certain cells without harming others, even when the two kinds of cell are close neighbours. This subject covers the drugs used for treating disease in man and in his economic animals; also the fungicides, insecticides and weed-killers that are used in agriculture. Both permanent and temporary injury are dealt with and related to chemotherapy and pharmacodynamics respectively.

The author begins by discussing the differences between species (and between different kinds of cells in a single species) that offer to toxicity the possibility of selectivity. The following three major sources are dealt with: differences in distribution, in cytology, and in biochemistry.

Four introductory chapters of general interest (particularly suited to the needs of students in biochemistry, medicine, pharmacy, veterinary science and agriculture) are followed by ten chapters of a more advanced character addressed to all research workers who are interested in biologically active substances. The nature of the bonds by which agents combine with receptors is discussed and full treatments given of ionization, chelation and the role of heavy metals, and stereochemistry.

The main headings of the chapters contained in this book are listed below: Toxicity in the Service of Man; Absorption, Distribution and Excretion; Chemotherapy; History and Principles; Pharmocodynamics; The Chemical Basis of Selectivity; The Nature of Bonds: Adsorption; Metabolites; Enzymes and Metabolite Analogues; The Influence of Methyl-Groups on Biological Action; Ionization; Metal-Binding Substances; The Covalent Bond in Selective Toxicity; Steric Factors; and Surface Chemistry; The Modification of Membranes by Agents; Free Radicals; Biological Activity Unrelated to Structure; and Ferguson's Principle. C. V. R.

Hematologic Reviews (Volume 1). Edited by Julian L. Ambrus. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y.), 1968. Pp. xi + 286. Price $ 16.75.

During the past decades hematology has expanded to the point at which it is difficult, even for the specialist, to keep abreast of developments in all its branches.

Hematology is traditionally divided into two principal branches: "morphologic" hematology, which deals with hemic cells and their diseases, and "enzymologic" hematology, which studies the blood coagulation system. Chemotherapy of the leukemias and lymphomas became an important area of study for the morphologic hematologist. This led to exploration of problems of drug metabolism and enzymatic defects and landed the morphologically and clinically oriented hematologist in the midst of enzymology. The hematologist studying the anemias found himself intimately involved in human genetics and in a different corner of enzymology and molecular biology. At the same time the blood coagulationist came to learn about the significance of the submicroscopic morphology of thrombocytes. Thus, the traditional differences in methods of working and ways of thinking between the two groups of hematologists are gradually disappearing. Many new areas of study are breaking away from their mother fields, as, for example, the gradual separation of the study of fibrinolysin system from the field of blood coagulation.

In this book, scientific reviews of theoretical and practical importance in various areas of hematology are presented. Clinical and laboratory hematology are equally considered. Topics covered in this volume include hereditary Anemias of Mice; von Willebrand's Disease; Idiopathic Thrombocytopenic Purpura; Thromboplastic Enzymes, Thrombokinase, and Related Components of the Blood Coagulation System; and Thrombocytopenic and Related Physiologic Effects of Heparin and Heparinoids. *Hematologic Reviews* will be of value to the hematologist, practising physician, physiologist, pathologist, radiation biologist, and biochemist. C. V. R.

Chemical Instrumentation (Vol. I, No. 1). Editor: Clemens Auerbach. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016.) Subscription: Vol. I, 4 numbers, $35.00; Foreign postage $3.00 per volume.

Apart from new ideas development in any branch of science is largely dependent on new tools that are brought into use to test these ideas. In no branch of science is this more evident than in chemistry. In this context the launching of a new journal devoted to chemical instrumentation is a definite step forward to fulfil the present needs in the rapid development of this subject which now includes biochemistry also.

Chemical Instrumentation is a quarterly journal published by Marcel Dekker, Inc., and issued in July, October, January and April. Vol. I, No. 1, July 1968, is the first number of the journal, and its 130 pages contain eight original articles and three notes. The subjects cover Polarography, Nuclear Magnetic Resonance, Laser Raman Spectroscopy, Spectropolarimeter and Spectrophotometer, Chromatography, and Differential Thermal Analysis. As pointed out by the Executive Editor Clemens Auerbach in the Introduction, the journal will serve as a forum for the entire domain of chemical instrumentation from an interdisciplinary viewpoint, and address itself to chemists, biochemists, biologists, engineers and all others concerned with experimental techniques in chemistry. A. S. G.

Elements of Statistical Thermodynamics. By L. K. Nash. (Addison-Wesley Publishing Co., Inc., West End House, 11 Hills Place, London W.1.) Pp. 128. Price 22 *sh*.

This book may be taken as a companion volume to the author's earlier book, *Elements of Chemical Thermodynamics*. The book is in two parts. The fundamental concepts of statistical mechanics, analysis of microcanonical ensembles, and derivation of the Boltzmann distribution law are dealt with in Part 1. In Part 2 these ideas are developed to concepts of entropy and equilibrium with new meaning and significance. Finally the reader is introduced to how thermodynamic magnitudes can be calculated from spectroscopic data. A. S. G.

Books Received

Systems Theory Research. Edited by A. A. Lyapunov. (Translated from Russian. by E. S. Spiegelthal). (Plenum Publishing Corporation, New York 10011), 1968. Pp. vi + 320. Price $ 27.50.

Electronic and Vibrational Spectra of Molecules. Edited by Acad. D.V. Skobel'tsyn. (Plenum Publishing Corporation, New York 10011), 1968. Pp. vii + 217. Price not given.

Animal Gametes (Female)—A morphological and Cytochemical Account of Yolk formation Oogenesis. By Vishwa Nath. (Asia Publishing House, Bombay-1), 1968. Pp. xviii + 195. Price Rs. 60·00.

The Bond to Carbon (Vol. I). By A. G. Macdiarmid. (Marcel Dekker, Inc., New York 10016), 1968. Pp. xiv + 603. Price $ 26.50.

Fluorine Chemistry Reviews (Vol 2). By Paul Tarrant (Marcel Dekker, Inc., New York 10016), 1968. Pp. viii + 184. Price not given.

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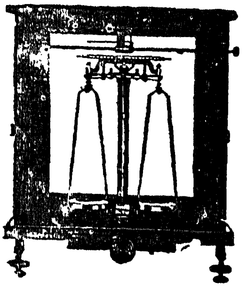

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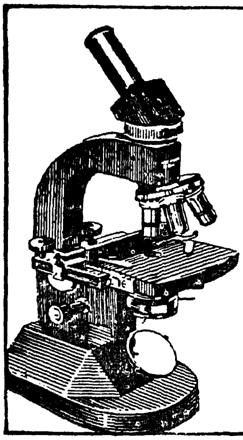

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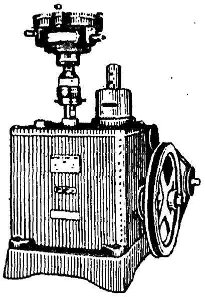

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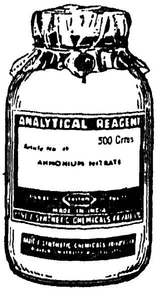

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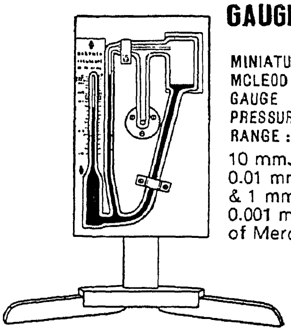

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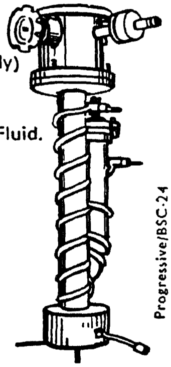

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STRESS RELAXATION AND STRAIN AGEING IN INDIAN COMMERCIAL ALUMINUM

Y. V. R. K. PRASAD, D. H. SASTRY AND K. I. VASU
Materials Research Group, Department of Metallurgy, Indian Institute of Science, Bangalore-12, India

ABSTRACT

Strain ageing has been observed in Indian commercial aluminum after relaxation at different stress levels which resulted in the appearance of a sharp yield point together with a change in yield stress. The activation volume estimated from the stress relaxation data is about $2 \cdot 5 \times 10^{-21}$ cm.^{3}

INTRODUCTION

RECENT investigations[1,2] on the nature of yielding and plastic flow in Indian commercial aluminum showed that its deformation behaviour is different from that of pure aluminum. It exhibits, unlike pure aluminum, logarithmic creep at room temperature.[1] It also shows a higher temperature dependence of flow stress.[2] While impurities may change the rate-controlling thermally activated low-temperature deformation mechanism from that of the intersection of dislocations in pure aluminum[3-6] to probably that of non-conservative motion of jogs, they may also form Cottrell atmospheres.[7] Although freeing the dislocation from Cottrell atmosphere is essentially an athermal process, Cottrell locking is in fact a prerequisite for the consideration of the model of non-conservative motion of jogs as the rate-controlling mechanism for plastic flow in commercial aluminum at room temperature.[2] The formation of Cottrell atmosphere manifests itself as the phenomenon of strain ageing. If the sample is strained to some extent, allowed to age and reloaded, an increase in yield stress followed by an yield drop is observed as a result of strain ageing. The aim of the present investigation is to examine the nature of strain ageing in Indian commercial aluminum subsequent to stress relaxation during tensile testing at room temperature. Stress relaxation in the plastic range as a process of thermal activation will also be studied.

EXPERIMENTAL

The experiments were carried out on Indian commercial aluminum of 99·5% purity (0·45% Fe + Si, 0·05% Cu and traces of Mg and Ti). The specimens were prepared from sheets of 2 mm. thickness rolled from ingot slices. They were machined with the tensile axis in the rolling direction. The specimens were annealed at 400° C. for 1 hour. The average grain diameter was 0·03 mm.

Tensile tests were conducted on Instron Testing machine using friction grips. The sample was strained at a rate of 0·05 cm./min. to a few tenths of a per cent and then allowed to relax at constant strain by stopping the machine for about 300 seconds after which straining was resumed at the previous strain rate. The procedure was repeated at various strain levels. While straining the sample, 0-100 kg. range was used for recording the load and during stress relaxation, 0-10 kg. range had been chosen. All tests were conducted at 25° C.

RESULTS

Figure 1 shows the typical cycle of relaxation experiments conducted on commerical aluminum. Relaxation is done at different stress levels and the stress relaxation curves are denoted by 'R'. It is to be noted that when the material is strained after relaxation a sharp yield point appeared in the stress-strain curve (marked 'A' in Fig. 1). At low strains, both the upper and lower yield points

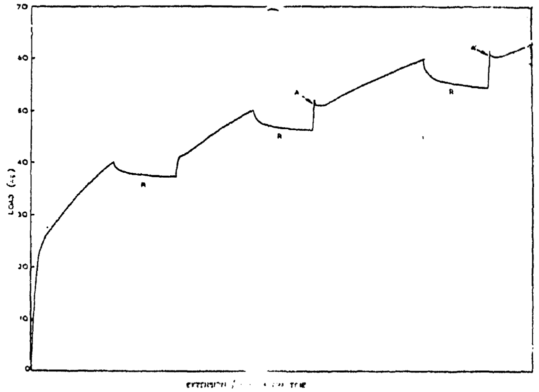

FIG. 1. Typical cycle of stress relaxation experiments on Indian commercial aluminum.

are higher than the flow stress before relaxation. The stress difference ($\Delta\sigma$) between the yield points (upper and lower) and the flow stress before relaxation is strain-dependent (Fig. 2). Beyond about 6% of strain $\Delta\sigma \leqslant 0$. The yield drop associated with the flow after relaxation is negligibly small below about 1% and after about 9% strain. It can also be seen that the lower yield point is followed by a plateau.

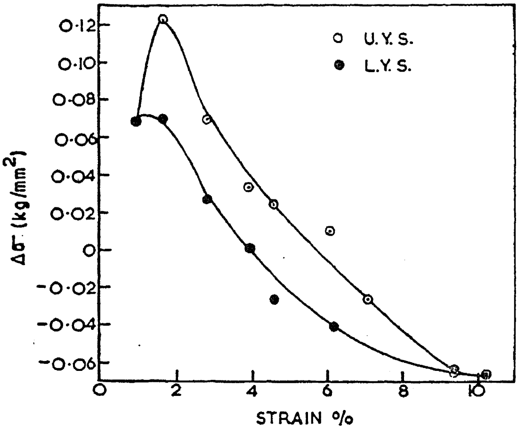

FIG. 2. Strain dependence of the flow stress increment ($\Delta\sigma$) due to strain ageing after relaxation.

The stress drop during relaxation is also plotted in Fig. 3 as a function of logarithm of relaxation time. For strains less than about 5% the tensile stress relaxed from its initial value σ_0 according to the logarithmic law:

$$\sigma_0 - \sigma = S \ln t \quad (1)$$

where σ is the relaxed stress at time t and S is a constant given by the slope of the plot $\sigma_0 - \sigma$ *versus* $\ln t$.

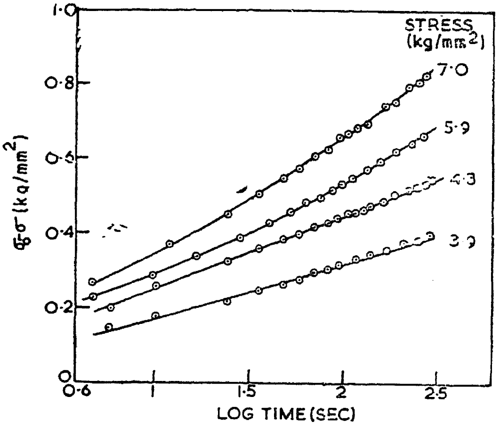

FIG. 3. Decrease in the stress as a function of relaxation time.

DISCUSSION

The occurrence of sharp yield point when the specimen is restrained after relaxation indicates that ageing takes place during the time of interruption of the test. This type of ageing, referred to as "strain ageing", is observed also in brasses, aluminum alloys and impure b.c.c. metals. This phenomenon was explained by Cottrell[7,8] to be due to impurity locking of dislocations. The impurity locking is also responsible for the yield drop observed and the increase in the yield stress after relaxation in the initial stages. The theories explaining the increase in the yield stress and the appearance of sharp yield point associated with an yield drop are based either on breakaway of dislocations from pinning atmospheres[7,8] or on the creation of new mobile dislocations.[9-11] In fact, it appears reasonable to think that atmosphere pinning of dislocations is the cause of the sharp yield point and when the applied stress is high enough to dislodge the atmospheres, there will be a sudden increase in the mobile-dislocation density causing the stress required to maintain flow to become low, *i.e.*, yield drop appears. The flat portion of the curve following the yield drop is associated with the yield point elongation and is related to the formation of Lüder's bands. These are localised places where yield first occurs and then spreads along the gauge length during which period the yield point elongation is observed. This is followed by usual strain hardening.

It is interesting to note that ageing during interruption of the test is not always followed by hardening (Fig. 2). It appears that whether hardening or softening occurs after relaxation depends on the stress level at which relaxation is done. So long as the relaxed stress obeys a logarithmic time law (Fig. 3), which implies that no dynamic recovery occurs, there appears to be an increase in the yield stress after ageing. At higher stresses, where the logarithmic law is not obeyed during relaxation, two factors are to be considered: one is the high dislocation density and the other is the dynamic recovery resulting in a decrease in the dislocation density. If the dislocation density is high, the small solute concentration may not be enough to cause condensed atmosphere formation for increasing the yield strength appreciably. Moreover, the dynamic recovery, probably involving cross slip, reduces the dislocation density considerably so that en the small increase in yield strength caused solute locking might be getting offset by e decrease in strength caused by dynamic covery.

Since stress relaxation in the plastic strain nge occurs by a process of thermally acti- ted motion of dislocations across the rriers,[12,13] it is possible to calculate one of e activation parameters, *viz.*, the activation lume from the relaxation curves. Activation lume, the product of the length of the dis- cation getting activated, the Burgers vector ıd the width of the barrier, characterises the stacle to dislocation motion. From the rela- on between creep and low temperature laxation, it has been shown[13,14] that the ope 'S' of the curve $\sigma_0 - \sigma$ *versus* ln t is ven by

$$S = kT/v \qquad (2)$$

here 'v' is the activation volume, k the oltzmann's constant and T the absolute tem- erature. The slopes of the straight lines rresponding to 3·9 and 4·8 kg./mm.^{2} are ilised to calculate the activation volume from quation (2). The estimated activation lume ($\simeq 2 \cdot 5 \times 10^{-21}$ cm.^{3}) is in good agree- ent with that reported earlier from creep periments.[1] While the estimated activation lume suggests that either intersection of ide and forest dislocations or the non-conser- ative motion of jogs is the rate-controlling echanism in Indian commercial aluminum, ır earlier results based on the combined data creep and tensile testing indicated that the on-conservative motion of jogs producing oint defects might be the most probable one.

CONCLUSIONS

Strain ageing experiments on Indian commercial aluminum showed the occurrence of sharp yield point associated with an yield drop. The increase or decrease in the yield strength after ageing depended on the stress level. The analysis of the relaxation curves yielded a value of $2 \cdot 5 \times 10^{-21}$ cm.^{3} for the activation volume.

ACKNOWLEDGEMENTS

We are thankful to Dr. S. Dhawan, Director and Prof. A. A. Krishnan for their interest in the work. We are also grateful to the authorities of N.A.L. for providing the Instron Testing Machine for conducting the experiments and to Mr. V. Sreenivasan, scientist, N.A.L. and Mr. M. V. J. R. Pantulu for their help during the experiments.

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TEST-TUBE FERTILIZATION IN *DICRANOSTIGMA FRANCHETIANUM* (PRAIN) FEDDE

N. S. RANGASWAMY AND K. R. SHIVANNA
Department of Botany, University of Delhi, Delhi-7

THE technique of test-tube fertilization devised by Kanta *et al.*[1] helps to eliminate he path of pollen tubes through the stigma nd style. It is therefore promising in studies n plant breeding and genetics, and has been hus far applied to a few systems.[2-5] This aper reports our successful application of the echnique to *Dicranostigma franchetianum* Papaveraceæ). Plants of this species were aised from seeds obtained from the Direktor, nstitute für Kulturepflanzenforschung, Gaterleben, East Germany.

As a prerequisite to our work, anthesis, dehiscence of anthers, pollination, fertilization, and seed development were studied from fresh material and from material fixed in formalin-acetic-alcohol (40% formaldehyde solution 5 ml + glacial acetic acid 5 ml + 70% ethyl alcohol 90 ml). The fixed material was embedded in paraffin following the customary method and microtomed (10–15 μ). The sections were stained in iron hæmatoxylin and erythrosin, and mounted in Canada balsam. Pollen germination and pollen tube growth were studied also from whole mounts and free-hand sections prepared in 1% iron acetocarmine.

Under the climate of Delhi *Dicranostigma franchetianum* flowers during February-April. Anthesis occurs between 8 and 9 a.m. Anthers begin to dehisce toward the evening the day before anthesis and continue to shed pollen until two hours after anthesis by which time pollination is also accomplished. Pollen germination occurs nearly 30 minutes after pollination and fertilization 24–36 hours thereafter. Six days after pollination a 2- to 4-celled

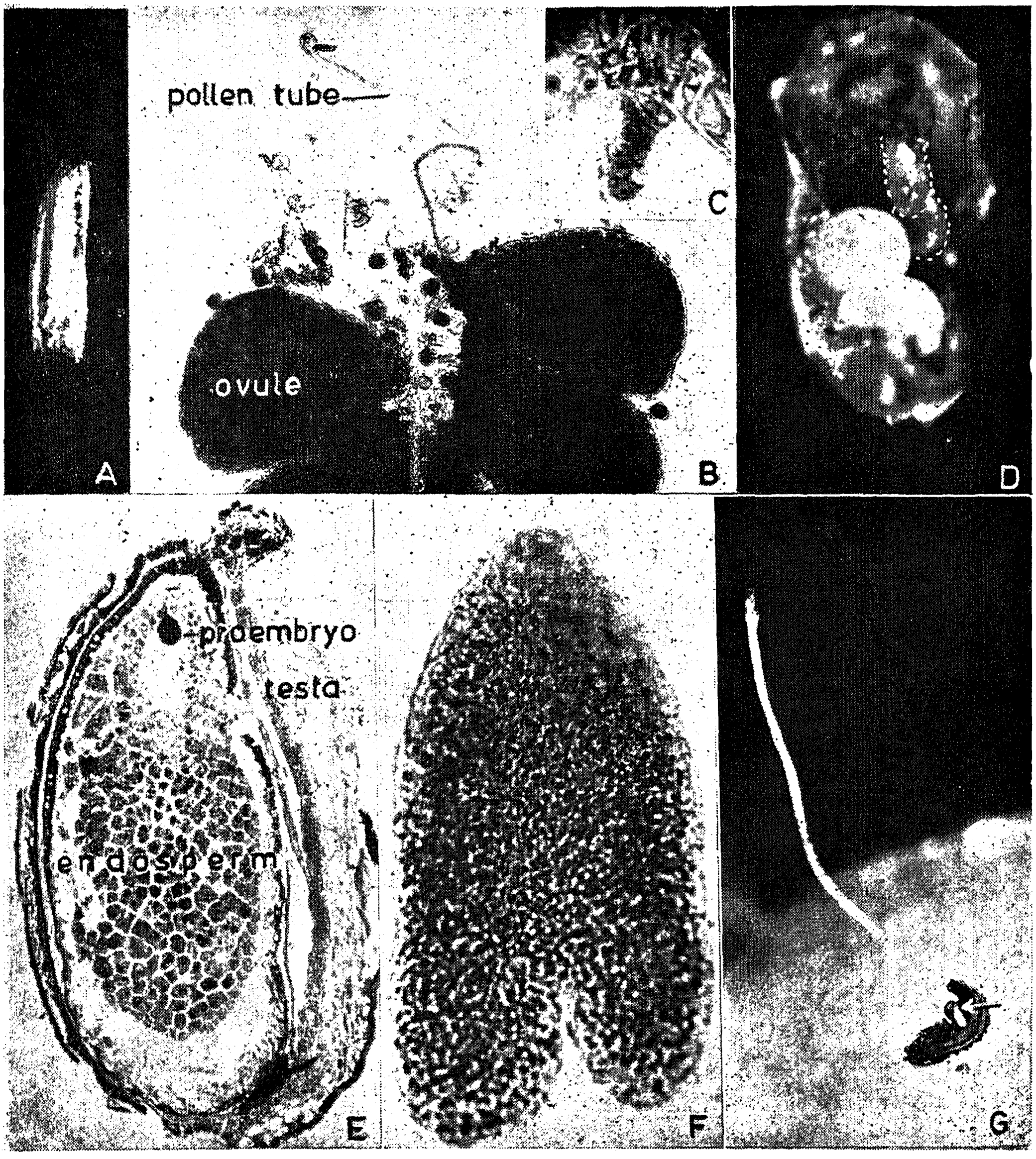

FIG. 1, A–G. Test tube fertilization in *Dicranostigma franchetianum*. A, An explant showing ovary wall, placenta, and ovules, × 6. B. Whole mount of a few ovules removed from a culture 24 hours after pollination; note pollen germination, × 121. C. Longisection of micropylar part of a fertilized ovule from a culture 4 days after pollination. The filamentous proembryo is obvious, × 102. D. 7-day-old pollinated culture showing 4 developing seeds; the 2 that are in profile are highlighted by broken lines; unfertilized ovules are not in focus, × 22. E. Longisection of a young seed collected from a culture 7 days after pollination. Globular embryo and massive endosperm are evident, × 110. F. Whole mount of embryo dissected from seed obtained from 18-day-old pollinated culture, × 345. G. 21-day-old pollinated culture showing seed germination *in situ*. In this view, the seedling does not show the root; the arrow-marked is a recently germinated seed which shows only the emergence of the radicle, × 4.

proembryo is formed in the developing seed. The embryo attains the early heart-shaped stage nearly 10 days after pollination. Mature seeds are formed 15 days after pollination. The mature seed contains a dicotyledonous embryo and a massive endosperm.

To apply the technique of test-tube fertilization, flower-buds were emasculated and bagged one day before anthesis. On the day of anthesis the emasculated buds were excised, their calyx and corolla removed, and their pistils surface-sterilized in fresh chlorine water for about ten minutes and washed twice in sterile distilled water. The ovary was vertically cut such that each half contained one placenta. From each half the tips were discarded, and the remaining portion bearing the ovules, placenta, and ovary wall (Fig. 1, A) was cultured on an agar nutrient medium containing Knop's mineral elements, four B-vitamins, glycine, and sucrose.[6] Thus two cultures were raised from each ovary; one of them was maintained as unpollinated control, and the other was sprinkled with pollen collected at random from about-to-dehisce anthers. In all, 96 cultures were prepared and maintained under 200 Lux diffuse daylight and 22 ± 2° C.

All 48 control cultures shrivelled in 5–8 days. Of the 48 pollinated cultures, 12 shrivelled, 3 became infected, 10 were used for embryologic studies, and the remaining 23 were grown until 21 days. In the pollinated cultures the pollen readily germinated, and the pollen tubes grew amidst the ovules (Fig. 1, B). Three days after pollination 2–5 ovules began enlarging as though they had been fertilized. Embryologic preparations of such enlarging ovules four days after pollination did show 4–8 endosperm nuclei and a zygote or occasionally a filamentous proembryo (Fig. 1, C). This confirmed double fertilization *in vitro*. During six days after pollination the fertilized ovules enlarged considerably (Fig. 1, D) and the unfertilized ovules shrivelled; the young seeds contained cellular endosperm and globular embryo (Fig. 1, E). In 15 days after pollination, mature seeds containing dicotyledonous embryo (Fig. 1, F) and endosperm were formed. Thus, from 23 cultures harvested 18–21 days after pollination, 88 seeds were obtained. Of these 16 seeds germinated *in situ* (Fig. 1, G). Upon harvest, 10 of the remaining 72 seeds were cultured on fresh nutrient medium; 7 of these produced normal seedlings. Studies on root tips of two seedlings showed that both seedlings contained the diploid number of 12 chromosomes.

Thus our investigations have demonstrated that the technique of test-tube fertilization is effective with *Dicranostigma franchetianum* also.

We are grateful to Professor B. M. Johri for facilities, and to the Council of Scientific and Industrial Research for a Research Fellowship to one of us (KRS).

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RADIOCARBON DATES FROM TER AND SOME OTHER HISTORICAL SITES

D. P. AGRAWAL, S. K. GUPTA AND SHEELA KUSUMGAR
Tata Institute of Fundamental Research, Bombay-5

ABSTRACT

The C^{14} dates presented are from historical sites. Of special interest are the dates from an Asura site, as also from the late phase of the N.B.P. ware. The samples were counted in the form of methane in gas-proportional counters.

In the present report are included the C^{14} dates from the sites* of Chandraketugarh, Chirand, Mailaram, Rajbadidanga, Saradkel, Ter, Tripuri and Ujjain.

Each sample has been given two dates in years B.P.; the first one is based on the half-life value of 5568 ± 30 yrs; within the parenthesis is given the second date, based on the half-life value of 5730 ± 40 yrs. To convert the dates to A.D./B.C. scale, 1950 should be used as the reference year (Godwin, 1962).

Before converting the samples into methane, they were pretreated for the removal of extraneous humic acid and carbonates. Rootlets were hand-picked, wherever visible. The samples, in the form of methane, were counted in gas-proportional counters. For modern reference standard 95% activity of the N.B.S. oxalic acid was used. Detailed procedures have already been described elsewhere (Kusumgar *et al.*, 1963; Agrawal *et al.*, 1965).

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* Short summaries of these excavations are published regularly in the *Indian Archaeology—a Review*.

GENERAL COMMENT ON DATES†

TF-446-places the late phase of N.B.P., in the first century B.C. The Asura site of Saradkel has been dated to the first century A.D. (TF-370). The early levels of Ter, a Satavahana site, have been ascribed to *ca.* 150 B.C.

C^{14} DATES WITH SAMPLE DESCRIPTION

Chandraketugarh, India

TF-367, Historical Deposits, 660 ± 90
(680 ± 95)

Shells from Chandraketugarh, District 24-Paraganas, West Bengal, Locus H 2, Depth 2·6 m., Sample No. 2. Sample submitted by C. R. Roy Choudhury, Asutosh Museum, Calcutta-14. Comment: Organic fraction was not sufficient, hence only inorganic fraction was dated.

Chirand, India

TF-446, N.B.P. Ware Deposits, 1930 ± 105
(1985 ± 105)

Charred rice from Chirand (Lat. 25° 45′ N., Long. 84° 45′ E.), District Saran, Bihar, Trench CRD-1 c, Locus B′-C′, Layer 6, Depth 3·25 m. NaOH pretreatment was also given. Sample submitted by Director of Archæology and Museum, Patna. Comment: Sample derives from the top of N.B.P. ware deposits.

Mailaram, India

TF-373, Historical Deposits, 520 ± 90
(535 ± 90)

Charcoal from Mailaram (Lat. 17° 43′ N., Long. 80° 37′ E.), District Khammam, Andhra Pradesh. Collection from a trench in an old slag heap, Depth 1 m., Field No. SK 3, Sample No. 1. Visible rootlets were hand-picked. NaOH pretreatment was also given. Sample submitted by S. N. Sen, Geological Survey of India, Hyderabad. Comment: Sample dates an earlier copper mining activity in the area.

Rajbadidanga, West Bengal, India

Rajbadidanga (Lat. 24° 01′ N., Long. 88° 11′ E.), District Murshidabad, was excavated by S. R. Das, Department of Archæology, University of Calcutta, who submitted the samples.

TF-629, Historical Deposits, 1495 ± 90
(1540 ± 95)

Charcoal from Trench B 3, Layer 12 A, Depth 3·5 m., Field No. 3. Comment: Associated finds have terracotta seals.

TF-634, Historical Deposits, 1520 ± 90
(1565 ± 95)

Charcoal from Trench B 5, Layer 8, Depth 3·1 m., Field No. 9.

TF-636, Historical Deposits, 1665 ± 95
(1710 ± 95)

Charcoal from Trench B 5, Layer 8, Depth 3·3 m.

Saradkel, India

TF-370, 'Asura' Culture, 1795 ± 100
(1850 ± 100)

Charcoal from Saradkel (Lat. 23° 03′ 30″ N., Long. 85° 21′ E.), District Ranchi, Bihar, Trench SDK-2, Locus A 1-A 2, Layer 3, Depth 0·07 m. (?), Field No. SDK-2/65-248. Submitted by Director-General of Archæology in India, New Delhi.

Ter, Maharashtra, India

Ter, District Osmanabad, was excavated by M. G. Dixit, Director of State Archæology, Maharashtra, Bombay, who submitted the samples. NaOH pretreatment was given to all the samples.

TF-746, Historical Deposits, 1645 ± 100
(1690 ± 105)

Charcoal from Layer 3, Registration No. 5/619.

TF-747, Historical Deposits, 2045 ± 100
(2105 ± 100)

Charcoal from Layer 22, Registration No. 5/573.

Tripuri, India

TF-681, Early Historic Period, 2155 ± 100
(2220 ± 105)

Charcoal from Tripuri (Lat. 23° 08′ N., Long. 79° 50′ E.), District Jabalpur, Madhya Pradesh, Locus II, Layer 5, Depth 2·8 m., Field No. 246. Sample submitted by H. D. Sankalia, Deccan College, Poona-6. Rootlets were hand-picked. NaOH pretreatment was also given.

Ujjain, Madhya Pradesh, India

Ujjain (Lat. 23° 11′ N., Long. 75° 46′ E.), District Ujjain. Samples submitted by Director-General of Archæology, New Delhi-11. Site excavated by N. R. Banerjee.

TF-407, Black-&-Red Ware(?) Deposits,
1990 ± 100
(2050 ± 100)

Charcoal, Locus, O-I, Layer 23, Depth 4·4 m., Field No. UJN 17 Ext/108. Comment: Date is younger than expected.

TF-409, N.B.P. Ware Deposits, 2335 ± 95
(2400 ± 95)

Charcoal, Locus IV-V, Layer 28, Depth 5·50 m., Field No. UJN 28/155.

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† The dates based on 5730 years half-life value have been used for discussions.

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LETTERS TO THE EDITOR

THE URANIUM QUADRUPOLE MOMENT BASED ON A DUAL CORE FISSIONABLE MODEL

DURING the fission of uranium by absorption of a slow neutron, it is known that both the charge and mass of uranium split into two unequal fragments. The distribution curve[1] of mass number of fragments shows the division into "heavy fragments" of mass number around 140 and "lighter fragments" of mass number around 100. This experimental observation is taken as the basis of the *new* model described here for interpreting the electric quadrupole moment of the nucleus. The uranium nucleus is assumed to consist of two cores A and B. The core A is taken as the most stable doubly magic shell structure[2] with 50 protons and 82 neutrons and the core B to consist 40 protons and 50 neutrons. The 40, however, is only a *weak* magic number. The remaining neutrons and the two protons are assumed to be moving in the axially symmetric field of these cores. These loose nucleons are shared by the two fragments of the nucleus and they are highly unstable against β-emission thus resulting in chains of beta-decays. The experimentally found low probability for ternary fission supports the inherent assumptions of the new model.

Earlier[3] a number of collective models of nuclei were suggested to explain the large quadrupole moments essentially involving some kind of co-operative movement of nucleons. On the other hand, the dual core model proposed above for the heavy nucleus considers the quadrupole moment mainly as arising from the loose protons apart from the direct core contributions. A compound nuclear wave orbital function (CNO) for the uranium nucleus is constructed as a linear combination of the nucleonic orbitals (LCNO). Two parameters λ and μ are introduced to consider the nucleon orbitals as probable admixtures of ($r = 7/2$ or $5/2$) near the core A and ($r = 9/2$ or $7/2$) near the core B respectively. The *new quantum number* r is introduced for assigning states to the different nucleons in the axially symmetric field.

The quadrupole moment is defined as $Q = Q_c + Q_p$ where Q_c and Q_p are the core and protonic contributions respectively. We have

$$Q_p = \langle \mathrm{CNO} \mid (3 \operatorname{Cos}^2 \theta - 1)\, r'^2 \,.\, \mathrm{CNO} \rangle$$

where θ, r' are relative to the centre of the uranium nucleus. The intercore separation 2R is chosen to have a value of the order of uranium nuclear radius thus consistent with saturation property of nuclear binding forces and Coulomb energy stimates.

Figure 1 (in which R is chosen to be 6 fm) illustrates the dependence of the calculated quadrupole moments on the nature of LCNO. The curves (1) and (2) indicate the variation of qudrupole moment calculated with anti-symmetrical LCNO while (3) and (4) involve a symmetrical LCNO. The parameter values adopted for λ are indicated on the respective curves.

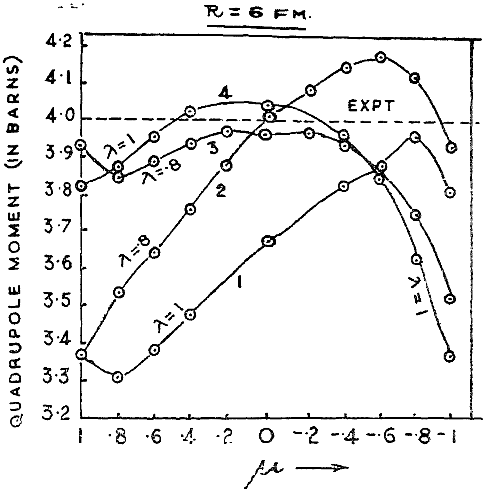

Fig. 1. The variation of quadrupole moment with μ for different λ values and with R = 6 fm. Curves (1) and (2) correspond to anti-symmetrical LCNO and (3) and (4) to symmetrically LCNO.

The experimental[4] quadrupole moments for $^{235}_{92}$U and $^{233}_{92}$U are about 4·0 barns in magnitude, their signs being ambiguous. From the figure it is evident that the positive values of 4·0 barns can be reproduced with appropriate sets of values of λ and μ. The present *dual* core fissionable model allows us to analyze the nuclear bonding of fissionable nuclei in terms of individual nucleon behaviour and especially interesting is the role of loose nucleons. It also characterises each nucleus with an inter-core distance.

The author is deeply indebted to Professor K. R. Rao and Dr. S. Ramamurthy, Andhra University, Waltair, for discussions and their encouragement. He also wishes to express his sincere thanks to Dr. N. A. Narasimham, Spectroscopy Division, BARC, Bombay, and Professor V. S. Patankar for their kind interest.

Physics Department, K. L. NARAYANA.
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SPECTRUM OF A LEONID METEOR

CONSIDERABLE efforts are made from different countries to obtain spectra of shower and non-shower meteors. This communication describes the third meteor spectrum taken from India, at Waltair.[1,2] The present meteor appeared on 17/18 November 1965 at 0325 hr. I.S.T. and was identified to be a Leonid. Its apparent visual magnitude was visually estimated to be *minus* one. The spectrum was photographed with a Contax 3A camera on an Ilford HP3 (400 ASA) 35 mm. film using a conventional meteor spectrograph with the rotating shutter arrangement. A Bausch and Lomb plane replica transmission grating, with 200 lines per mm. and blazed for 5000 Å was fixed in front of the camera. Seven spectral lines are measured in this spectrum, reproduced in Fig. 1, and their identifications presented in Table I.

It may be seen from Fig. 1 that the brightness of the trail has increased from the Ist to the 2nd segment. The discontinuous nature of the brightness in the middle of the 2nd segment may be due to chipping off of a fragment and a consequent decrease in the mass of the main meteoroid. The inclined spectral line of medium intensity (numbered 6th in Table I) which started at 5257·4 Å at the discontinuity in the middle of the 2nd segment has its wavelength varying upto 5341·6 Å towards its end. This forking could be attributed to the lateral movement of the fragment of iron chipped off from the main particle and excited by ablation to give the spectral line of Fe I (1) which is a definite identification in meteor spectra (*see* Millman[3]).

TABLE I

Wavelengths and identifications of spectral lines

Sl. No.	Mean wave-length in Å	Atom or ion.	Multiplet No.	λ lab in Å	Excitation potential in ev.	Relative intensity
1	3933·7	Ca II	1	3933·7	3·14	Very strong
2	3969·9	Ca II	1	3968·5	3·11	do.
		Fe I	43	3969·3	4·59	
3	4823·0	Mn I	16	4823·5	4·87	Medium
4	4917·0	Fe I	318	4919·0	5·36	do.
				4920·5	5·33	
5	5172·7	Mg I	2	5172·7	5·09	Strong
		Fe I	36	5171·6	3·86	
6	5257·4	Fe I	1	5255·0	2·46	Medium (Forked)
7	5893·0	Na I	1	5890·0	2·10	Strong
				5895·9	2·09	

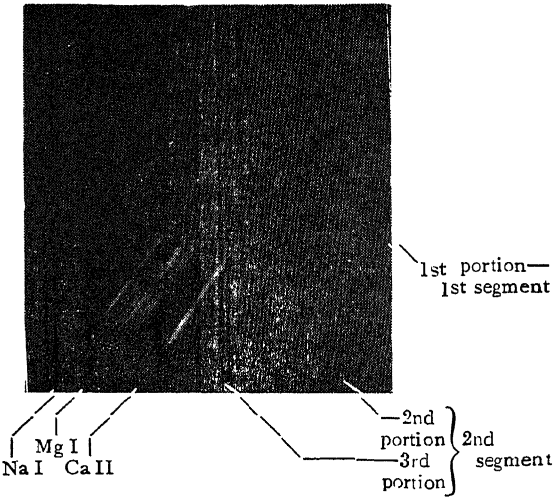

FIG. 1. Spectrum of the leonid meteor observed at 0325 hrs. on 17/18, November 1965.

The Leonid meteor spectrum described above may be classified as of the '*d* Y' type following Millman[3] as it has the H and K lines of calcium as the strongest features. The four chemical elements Na, Mg, Mn and Fe identified in this spectrum are quite commonly identified in other meteor spectra. The maximum excitation potential attained in this spectrum is only 5·36 ev. As this has only

7 spectral lines and is of '*d*' quality, it is essentially a weak spectrum. The excitation potentials of the gaseous elements (H and N) both in the neutral and ionized states are higher than 10 ev and hence are not recorded here, as in the case of the Leonid meteor spectrum of Rao and Lokanadham.[1] Although the excitation potential of the forbidden oxygen green line at 5577·4 Å is only 4·17 ev, it is not recorded here. This is probably because this OI line is usually recorded at larger heights whereas the present spectrum which contains only the last two segments corresponds to a lower height. Evidence for this is found from the work of Millman[3] and Lokanadham.[4]

Meteor. Res. Laboratory, M. SRIRAMA RAO.
Department of Physics, P. V. S. RAMARAO.
Andhra University,
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HALF LIFE OF THE 206 keV LEVEL IN Re^{187}

MOST of the K-forbidden transitions are found to have retardations of the order of 100–1000 per K-forbiddenness number as compared with the Single Particle Estimate. The 206 keV level in Re^{187} has the orbital numbers $\frac{9}{2}\,\frac{9}{2}^{-}$ (5 1 4) where the orbitals are in the sequence $KI\pi\,(NN_z\,\Lambda)$. This level de-excites by the emission of 72 keV gamma-ray terminating at the 134 keV level which has the orbital numbers $\frac{5}{2}\,\frac{7}{2}^{+}$ (4 0 2). Thus the 72 keV gamma-ray which is E_1 in nature is a K-forbidden transition. The half life of this level has been measured with delayed coincidence spectrometer to calculate the retardation factor with respect to Single Particle Estimate.

The isotope W^{187} was obtained from Bhabha Atomic Research Centre, Bombay, in the form of Sodium Tungstate in aqueous solution. A delayed gamma-gamma experiment was carried out to measure the half life of 206 keV level. For the detection of gamma-rays, two Na I (TI) crystals of 4·4 cm. height and 5·1 cm. dia. coupled with Dumont 6292 Photomultiplier tubes were used. A slow-fast coincidence spectrometer was set with resolving time $2\tau = 0\cdot15\,\mu$ sec. The resolving time of the circuit was measured by introducing accurately known delays in both the channels. This value was further checked by chance coincidence method.

To measure the half life of this level, the gamma-rays of energy between 450–500 keV were accepted in one channel which feed the 206 keV level. The 72 keV gamma-ray was chanelled in the other channel. The coincidences were obtained by delaying the 480 keV gamma-ray for known delay times. The experiment was repeated four times. After subtracting the chance coincidences the delayed coincidence curve was obtained. The half life of the 206 keV level was obtained to be $0\cdot52\,\mu$ sec. In the measurement a total of 5% error may result from the instrument calibration and measurement of cable lengths. Hence the half life of the 206 keV level may be written as,

$$T_{\frac{1}{2}}(206) = (0\cdot52 \pm 0\cdot03)\,\mu \text{ sec.}$$

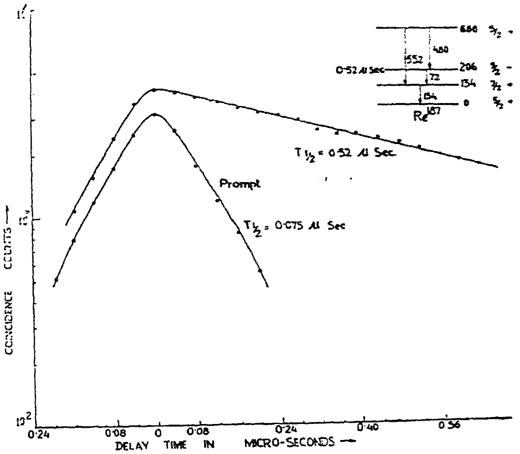

FIG. 1. Time analysis of the coincidences between 480 keV gamma-ray and the 72 keV gamma-ray.

This value is in agreement with previous measurements.[2-6] From the above result the transition probability $T_{(el)\,exp}$ was calculated. As pointed out by Bashandy *et al.*,[7] the 72 keV gamma-ray is a pure E_1 transition, the total conversion coefficient for this transition was calculated and the $T_{(el)\,exp}$ was obtained to be $7\cdot89 \times 10^5$ sec.$^{-1}$. The theoretical E_1 transition probability for the 72 keV gamma-ray is $1\cdot87 \times 10^{12}$ sec.$^{-1}$. It gives a retardation factor of $2\cdot38 \times 10^6$ to this transition.

The retardation factors for other ΔK, E_1 transitions range between 10^4–10^7. The present measurement is in agreement with the empirical rule.[1] The possible cause of such a high retardation may be that the states from which the K-forbidden transitions originate are two quasi-particles states. The coupling between these two is responsible for K-isomerism. The retardations of the transitions may be the measure of the impurity of the states.

The author is thankful to Dr. M. L. Sehgal for valuable suggestions. He is also thankful to Prof. Rais Ahmed for his interest in the work.

Department of Physics, M. S. RAJPUT.
Aligarh Muslim University,
Aligarh (U.P.), *December* 14, 1968.

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OXIDATION OF DIPHENYL SULPHOXIDE WITH CHLORAMINE-T

THE characteristics of oxidation of dimethyl sulphoxide by chloramine-T to the sulphone was reported recently by us.[1] In absence of chloride ions, the reaction was fastest at pH 4·7 being many times faster than the permanganimetric[2] oxidation in strong acid medium. In presence of chloride ions, the reaction rate with chloramine-T was enhanced at higher acidities but then partial chlorination of methyl groups also resulted. The rate of oxidation of sulphoxides RR'SO to the corresponding sulphones is hindered[3,4] by the presence of strongly electron withdrawing substituents and steric hindrance at the reaction site. Thus whereas 0·025–0·1 millimoles of dimethyl sulphoxide can be quantitatively oxidised by acidified permanganate in about 10–15 minutes, under similar conditions it requires nearly 24 hours for complete oxidation of same amount of diphenyl sulphoxide to diphenyl sulphone. In continuation of our studies, we observed that the superiority of chloramine-T over potassium permanganate is even better illustrated in the oxidation of aromatic sulphoxides.

In Table I are recorded a representative set of results obtained for oxidation of diphenyl sulphoxide (dissolved initially in acetic acid) by aqueous solutions of chloramine-T under different experimental conditions. The unused chloramine-T in each case was determined iodometrically. It could be seen that in general the oxidation is extensive in acid media and in absence of chloride ions reaches a maximum at pH 4·7. In presence of small amount of chloride ions, however, the oxidation at higher acid concentration is greatly facilitated and is completed in 5–10 minutes. The product of oxidation was exclusively diphenyl sulphone as confirmed by elemental analysis, melting point and infrared spectrum. The diphenyl sulphone separates out as white crystals during oxidation. There was no side reaction unlike in the case of dimethyl sulphoxide. Hence we recommend the use of chloramine-T as oxidant for the rapid and accurate determination of aromatic sulphoxides in hydrochloric acid medium (0·1–0·5 M).

TABLE I

Oxidation of diphenyl sulphoxide (DPSO) with chloramine-T (CAT) at 25–30° C.

Amount of diphenyl sulphoxide taken = 0·1426 m. mole.
Amount of chloramine-T added = 0·5000 m. mole.
Total volume = 100 ml.

Medium	Duration of keeping reaction mixture min.	CAT consumed in mole	m. mole CAT used / m. mole DPSO taken
0·1 – 0·5 M HCl	5	0·1422	0·9970
	10	0·1422	0·9970
	30	0·1421	0·9963
0·1 – 2 M H_2SO_4	15	0·0962	0·6745
	30	0·1213	0·8506
	60	0·1369	0·9598
	90	0·1422	0·9970
pH 2·65*	5	0·1197	0·8112
	30	0·1420	0·9956
pH 4·7*	5	0·1283	0·8995
	30	0·1420	0·9956
pH 5·5*	30	0·1059	0·7423
	60	0·1314	0·9212
0·1 N NaOH	30	No reaction	No reaction
	60	No reaction	No reaction

* Buffers used : Acetic acid-sodium acetate.

Depending on the pH conditions, the chlorine oxidant in chloramine-T solutions can be one or more of the following species: $RNCl^-$, $RNHCl$, $RNCl_2$, Cl_2 (where $R = CH_3C_6H_4SO_2$). In 0·1–0·5 M HCl media, the DPSO gets oxidised presumably by the chlorine formed in the fast pre-equilibrium reaction $RNHCl + H^+ + Cl^- \rightleftharpoons RNH_2 + Cl_2$. In the absence of chloride ions, however, the most effective chlorine oxidant is dichloramine-T as indicated by the observation that the reaction is then fastest at pH 4·7 at which pH value the rate of formation and equilibrium concentration of dichloramine-T in chloramine-T solutions are known to reach the maximum.[5]

Protonation of the sulphoxides appears to be essential for their oxidation by chloramine-T solutions. In alkaline media, no oxidation occurs. Reaction between diphenyl sulphoxide and RNHCl or $RNCl_2$ in organic phase such as carbon tetrachloride and benzene was found to be very limited.

The kinetics of oxidation of various sulphoxides with chloramine-T in acid media both in presence and absence of chloride ions are being worked out in order to elucidate the mechanism of the reactions.

Department of Chemistry, V. R. S. Rao.
Indian Institute of G. Aravamudan.
Technology,
Madras-36, India, *February* 19, 1969.

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SPECTROPHOTOMETRIC INVESTIGATIONS OF TITANIUM (IV)-OXINE N-OXIDE COMPLEX

Though polyphenols, o-hydroxy phenyl carboxylic acids and hydroxy-γ-pyrones have been suggested as sensitive colorimetric reagents for titanium (IV), the use of these ligands is limited due to easy auto-oxidation of these compounds,[1] especially in alkaline medium. Hence there is need for more satisfactory reagents.

Oxine N-oxide resembles the peri-dihydroxy compounds in forming a six-membered chelate ring through two oxygen donors. It has been observed that on the addition of aqueous oxine N-oxide to aqueous titanium (IV) chloride, an orange-yellow water-soluble complex is produced and the present communication deals with its spectrophotometric investigations.

The absorption spectrum of the solution containing 8×10^{-5} M titanium (IV) and varying concentration of the reagent (metal : reagent ratio varying from 1 : 1 to 1 : 10) at pH 2·5 against reagent as blank showed the presence of a single absorption maximum at 405 mμ, thereby indicating the presence of a single complex. The absorbance of the solution containing titanium (IV) and oxine N-oxide in the molar ratio 1 : 10 remained constant and maximum at pH 4·2–5·0. At higher pH, the solutions became opalescent due to the hydrolysis of titanium (IV), while at lower pH the complex formation is incomplete. For complete colour development at pH 4·2–5·0, a minimum of 350 times reagent concentration is necessary. Beer's law is not obeyed in case of aqueous solution of this complex because of its high dissociation and the low solubility of the reagent in water. The molar absorption of the complex with 400 times reagent concentration, using reagent as blank at 405 mμ was found to be $1 \cdot 0 \times 10^4$ per mole of titanium (IV). But the reagent has higher solubility in ethanol and 50% aqueous ethanol was used as a medium for the spectrophotometric determination of titanium (IV), and it was observed that under these conditions, a minimum of 300 times reagent concentration was necessary; and the complex obeyed Lambert-Beer's law within 0·2 to 2·0 ppm titanium (IV) in presence of sufficient reagent.

During the estimation of 0·5 ppm Ti(IV), the limit of tolerance of foreign ions was found to be 8 ppm for thorium (IV), 4 ppm for cobalt (II), 4 ppm for nickel (II), 15 ppm for acetate, 4 ppm for tartrate and 1 ppm for citrate ions. Iron (III), chromium (III), vanadium (IV), zirconium (IV), cerium (IV), uranium (VI), sulphate, oxalate and phosphate ions, however, were found to interfere even when present in minute quantities.

The molar composition of titanium (IV)-oxine N-oxide complex, determined by the modified method of continuous variations[2] was found to be 1 : 2 at pH 2·0 as well as at pH 4·0 (in presence of 0·001 M sodium acetate, no mixed ligand complexes being detected in the system) at 385–440 mμ. These results were also confirmed by Asmus's straight line method[3] and by the logarithmic method of Bent and French.[4]

The pK_a of oxine N-oxide in aqueous solutions was spectrophotometrically found to be $9 \cdot 3 \pm 0 \cdot 1$ at 25° C. The equilibrium constant K for the reaction

$$TiO^{++} + 2HL = TiOL_2 + 2H^+$$

as determined by (*a*) Harvey and Manning's method,[5] (*b*) Foley and Anderson's method,[6] and (*c*) Asmus's method[3] was found to be $(4 \cdot 0 \pm 1 \cdot 8) \times 10^5$ at pH $3 \cdot 5 \pm 0 \cdot 1$ in aqueous medium at 25° C. The stability constant (β_2) of the complex determined by the above-mentioned methods as well as from the Bjerrum's formation curves obtained spectrophotometrically[7] was found to be as log $\beta_2 = 17 \cdot 2 \pm 0 \cdot 2$ in aqueous medium at 25° C.

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Department of Chemistry, R. D. GUPTA.
University of Delhi, G. S. MANKU.
Delhi-7, India, A. N. BHAT.
January 30, 1969. B. D. JAIN.

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IONIC ADDUCTS OF AMIDES

MUCH interest has been shown in the donor properties of amides and a large number of donor-acceptor complexes with Lewis acids have been isolated. N.m.r. studies of the solutions of amides in fluorosulphuric acid[1] have proved conclusively that the amide donation is through the carbonyl oxygen rather than through the nitrogen atom as was previously visualised.[2] Infra-red spectral analysis[3,4] also supports the donor character of carbonyl oxygen and these complexes have been found to be non-ionic in nature. In the case of non-stoichiometric complexes of composition $SnCl_4 . 4CH_3CONH_2$, the excess of the amide molecules are attached to the complex through hydrogen bonding and from conductance studies in acetic acid it has been concluded that these complexes are protonic in nature.[5]

Tellurium tetrachloride has been found t
be ionic in the solid[6,7] and molten stat
Infra-red spectral analysis of its comple
with bases[9] suggests that they are ionic i
nature as

$$TeCl_4 + 2Py \rightarrow TeCl_4 . Py_2 \rightleftharpoons [TeCl_3 . Py_2]^+ + Cl$$

We have isolated a number of complexes
tellurium tetrachloride with amides and su
stituted amides, and in this communicatio
report their ionic nature.

The complexes of tellurium tetrachlori
with amides, *e.g.*, acetamide, N-methyl acetami
dimethyl acetamide, N-methyl formami
formamide and dimethyl formamide have be
isolated in dry benzene and their stoichi
metric compositions have been established fr
the elemental analyses (Table I). Infra-r
spectra of pure amides undergo a signific
change on complex formation. Though w
have recorded the I.R. spectra of all the
complexes, yet for brevity discussion shall
limited to the spectrum of tellurium tet
choride-acetamide adduct.

The amide-1 band which is due to carbo
stretching frequency at 1685 cm.$^{-1}$ is displac
to a lower spectral region, *i.e.*, 1650 cm.
indicating the donor character of the carbon
oxygen of the amide. A slight increase in t
stretching vibrations of N–H band fro
3445 cm.$^{-1}$ to 3455 cm.$^{-1}$ and that of C–N ba
from 1410 cm.$^{-1}$ to 1440 cm.$^{-1}$ also confir
that tellurium tetrachloride has combined wi
acetamide through carbonyl oxygen. For
weaker Lewis acid like tellurium tetrachlori
the shift in the amide band, though small,
quite significant and indicates complex fo
mation.

Far infra-red spectral analysis of this addu
shows a broad band at 240 cm.$^{-1}$ which
slightly resolved. This is a characterist
absorption band for five co-ordinate tellurium.
The lowering of Te-Cl frequency (pure TeC
Te-Cl 360 cm.$^{-1}$) is because of the increase
the co-ordination number of tellurium fr

TABLE I

	Amide used		Stoichiometric composition $TeCl_4$: Amide	Colour	Analysis			
					Required % Te	Found Te	Required % Cl	Found Cl
1.	Acetamide	..	1 : 2	Yellow solid	32·86	32·92	36·50	36·30
2.	N-methyl acetamide	..	1 : 2	,,	30·71	30·76	34·14	32·67
3.	Dimethyl acetamide	..	1 : 2	Yellow viscous liquid	28·76	28·37	32·02	32·00
4.	N-methyl formamide	..	1 : 2	Yellow semi-solid	32·98	32·86	34·17	34·12
5.	Formamide	..	1 : 2	,,	35·48	35·42	39·49	38·67
6.	NN-dimethyl formamide	..	1 : 2	Yellow solid	30·71	30·16	34·14	34·09

three to five.[11] Similar observations have been reported by Wilkins and co-workers in their complexes of tellurium tetrachloride with pyridine.[12]

Molar conductance values in nitromethane are very close to those reported for 1 : 1 electrolytes suggesting that the complexes are ionic in nature. The presence of the pyramidal cation $TeCl_3^+$ a strong electrophile in the solid state helps the donor molecule to attach itself to the cation. The various ions present in the adduct may be postulated as

$$TeCl_4 . 2AcNH_2 \rightleftharpoons [TeCl_3 . (AcNH_2)_2]^+ + Cl^-.$$

This observation is unlike the previous reported donor-acceptor complexes of Lewis acid-amides which are non-ionic in nature.

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Dept. of Chemistry,　K. C. Malhotra.
Panjab University,　Krishan Kant Paul.
Chandigarh-14, *December* 13, 1968.

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WITHAFERIN-A FROM THE ROOTS OF *WITHANIA COAGULANS*

Withania coagulans Dunal (Family : Solanaceæ) is recorded to be useful in the Indian indigenous system of medicine[1,2] and the fruits of the plant have been earlier studied for their alkaloids[3-5] and pharmacological properties.[6] Very recently, there has been some special interest in the study of chemical components of *Withania somnifera* and besides its alkaloids, a new group of interesting steroidal lactones under the general name of 'withanolide' has been studied in detail.[7,8] In view of this and the fact that the roots of *W. coagulans* have not been chemically investigated earlier, they have been systematically examined for their chemical components, and the results are recorded in brief.

Dried roots of *W. coagulans*, coarsely powdered, were extracted by cold percolation with methanol, and the total percolate concentrated *in vacuo* to remove all the organic solvent with the addition of some water towards last stages of concentration. The aqueous concentrate was repeatedly shaken with petroleum ether, ether and chloroform in succession and the different fractions were separately studied. The petroleum ether extract contained only waxy material. The residue from the ether extract (positive steroid colour reactions) was chromatographed on neutral alumina (E. Merck) and eluted with petroleum ether, petroleum ether-benzene mixtures (9 : 1, 3 : 1, 1 : 1), benzene, benzene-chloroform mixtures (9 : 1, 3 : 1, 1 : 1) and finally chloroform. The residue from the benzene-chloroform (1 : 1) mixture and chloroform eluates contained the major crystalline substance, answering the reactions for withanolide. When recrystallised twice, it came out as colourless prisms, m.p. 241–43° (ethyl acetate), 158–60° (aq. ethanol), $C_{28}H_{38}O_6$, $[\alpha]_D^{28} +115°$, TLC single spot, R_f : 0·39 (silicagel G-Merck, ethyl acetate-benzene = 7 : 3, identified by exposure to iodine vapour). On acetylation, it gave a diacetate, m.p. 198–200°, $[\alpha]_D^{28} +190°$, and on treatment with conc. sulphuric-acetic acid mixture, it underwent rearrangement to yield a compound, m.p. 225–27°. All the above data agreed with those recorded[7,8] for withaferin-A, and the final identity was confirmed by direct comparison of colour reactions, co-chromatography and mixed melting points with authentic samples of withaferin-A and its derivatives, from the genuine leaves of *W. somnifera*. The antibacterial activity of the two samples was also compared and found to be identical. Besides withaferin-A, another withanolide, m.p. 270–72°, $[\alpha]_D^{28} +102°$, TLC, R_f : 0·6 was also obtained from the benzene eluate. It did not exhibit any antibacterial property and for want of sufficient quantity, it could not be characterised further.

The residue from the chloroform shakings of the aqueous extract on chromatography over alumina also yielded a further amount of withaferin-A (total yield, 0·15%).

The isolation of withaferin-A, known to have antibacterial[9] and antitumour[10] properties from *W. coagulans* recorded now, may also be significant in the chemotaxonomy of the genus *Withania*.

We thank the Director, Central Ayurvedic Research Institute, Jamnagar, for the supply of genuine leaves of *W. somnifera*, Dr. K. B. Sharma for bacteriological testings, and Dr. M. N. Ghosh and Principal, Dr. D. J. Reddy for kind encouragement. We are grateful to Dr. E. Glotter for authentic withaferin-A.

Depts. of Chemistry S. Sankara Subramanian.
and Pharmacology, P. D. Sethi.
Jipmer, Pondicherry-6,
February 5, 1969.

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UPTAKE OF I-131 BY MARINE ALGAE AND THE FACTORS INFLUENCING IODINE ENRICHMENT BY SEAWEEDS FROM SEA-WATER

Iodine is one of the essential elements for human and animal life and is also required in considerable amounts for the manufacture of many pharmaceutical drugs, photographic chemicals and as an analytical reagent. India has no major potential source of iodine other than some seaweeds, in which the enrichment of iodine from sea-water was reported[1,2] to be appreciable (100–500 mg./100 g. of dried algæ) but not enough for any industrial exploitation. To understand and enhance this enrichment, studies on uptake and turnover of iodine under varied conditions using radioactive I-131 are now carried out. The present experiments on the enrichment factors (*i.e.*, state of equilibrium between seaweed and sea-water) in various marine algæ and the influence of water temperature, light, pH and physicochemical state on the enrichment have led us to some important observations which are given below.

The experimental details remain the same as described earlier.[3] In all the experiments, 1–2 g. of freshly collected marine algæ (Sp.) after washing with filtered sea-water and blotted dry, were dropped in 50 ml. sea-water containing about 225 μμ c. of radioactive I-131 (500 cpm./ml.) and exposed to sunlight (lux 30,000) for various periods. Similar experiments were carried out by varying other parameters. The enrichment factors were then calculated as the activities (cpm./g.) found in 1 g. of seaweed (after drying the material at 105° C. for 4 hours) to that found in 1 ml. of sea-water. The results of various experiments are tabulated and shown in Table I.

Table I

Enrichment factors for various marine algœ at different temperatures, light and pH

(Unless otherwise mentioned all experiments were performed under sunlight : for 1 hr. at 30,000 lux)

Algal species		Enrichment factors (K)						
		r.t. (27°C, pH 7·9)		pH			temp. (°C.)	
		K_{light}	K_{dark}	7·9	5·8	2·6	23	13
1. *Aspergopsis* sp.	..	318	101	318	226	24	318	119
2. *Myriogloea sci.*	..	395	119	335	255	28	335	150
3. *Cystoseira ind.*	..	345	52	315	182	..	315	95
4. *Cladephora monu.*	..	285	47	285	215	..	285	126
5. *Sargassum* Johns.	..	143	13	143	85	..	143	65
6. *Enteromorpha tubu.*	..	84	18	84	34	..	84	57
7. *Gracilaria milar.*	..	72	6	72	24	..	72	33
8. *Ulva fasc.*	..	51	27	51	44	4	..	..
9. *Sarconema* sp.	..	26	..	..	..	..	..	..
10. *Dictyopteris* sp.	..	5·4	..	..	..	..	..	..

Appreciable enrichment of I-131 is seen in the first four species. However, these values are much lower than those reported with stable isotopes (100–30,000).[4] It is observed generally that with species 5, 6 and 7 much more illumination time is required to reach equilibrium and it is difficult to get K values by rearing experiments. The effect of decreasing pH is in general to lower the K values by as much as 92% (Sp. 1, 2 and 8) which may be attributed to some anion exchange reactions taking place at the surface of algæ involving iodine. Seasonal variations, size and/or age of organisms also seem to have affected the uptake but not of any significance.[5] However, stable iodine if deliberately added to the solution (100 μg. of stable I_2/litre) brought down the K values[5] by 90%.

Temperature and illumination enhance the enrichment in general by a factor of about 2, with *Myriogloœa* and *Cystoseira* species, the light illumination has a profound influence on the iodine enrichment as can be seen from Table II. This may be attributed to a direct photo-increase in the rate of biological processes taking place under these conditions.

TABLE II

Enrichment of iodine-131 and light illumination in selected marine algal species

Algal species	Enrichment factor, K_{light} illumination (lux), 1 hr. sunlight			
	10,000	20,000	30.000	40,000
1. *Astergopsis* sp. ..	253	284	318	330
2. *Myriogloea sci.* ..	270	335	395	462
3. *Cystoseira ind.* ..	215	279	345	387
4. *Cladophora monu.*	180	234	285	342
5. *Sargassum* Johns	90	122	143	159

It appears from Table II that iodine enrichment from sea-water using *Cystoseira ind.* (or seasonally available *Myriogloea* sp.) species which are available throughout the year can be profitably brought about under artificial conditions by varying the light illumination and environment, thereby enhancing the rate of biological processes in the system.

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Central Salt and Marine
Chemicals Research
Institute,
Bhavnagar,
January 28, 1969.

(MISS) J. M. PAREKH.
B. J. BHALALA.
S. T. TALREJA.
Y. A. DOSHI.

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PRESENCE OF A CARTILAGINOUS SUPPORT IN THE HEART OF *PTYAS MUCOSUS* (LINN.)

A CARTILAGINOUS support in the heart of chelonians, lacertilians and crocodilians is reported to be frequently present,[2] but there are few such reports of the presence of a cartilaginous support in the ophidian heart. However, such a cartilaginous support in the heart of *Typhlops braminus,* in which it is small, rod-like, and lies in the vicinity of the pocket valves of the aortic trunks, has been reported.[1]

While investigating the problem of blood circulation in reptiles, I found the presence of a fairly large hyaline cartilage (Fig. 1), in the heart of *Ptyas mucosus.* This cartilaginous support is dome-shaped and is uniformly thick around its margin but somewhat thinner centrally. It is located dorsal to the anterior edge of the interventricular septum and slightly to the right of the right systemico-carotid arch opening. It is placed more or

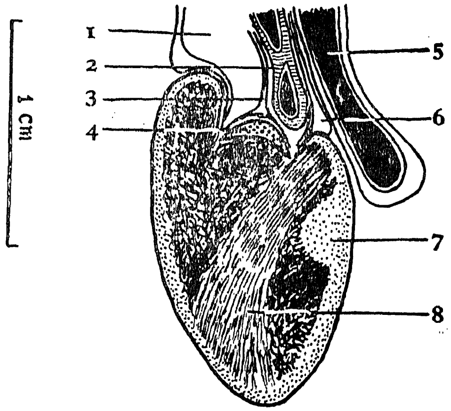

FIG. 1. Dissection of heart of *Ptyas mucosus* from the dorsal side. 1. Left auricle; 2. Systemico-carotid arch; 3. Interauricular septum; 4. Cartilage; 5. Right pre-caval and the post-caval; 6. Right auricle; 7. Interventricular septum; 8. The vertical septum.

less juxtaposed to the valve bearing end of the inter-auricular septum. The concavity of the cartilage faces cavum dorsale of the ventricular cavity.

Such a shape of the cartilaginous support in a reptilian heart appears singular, being neither unifocal as in Chelonia or in Lacertilia nor multifocal as in Crocodilia.[2]

A satisfactory functional interpretation of such a cartilage becomes rather difficult. However, disposed as it is in *Ptyas mucosus*, the cartilage appears to impart some degree of rigidity to the valve-bearing end of the inter-auricular septum, preventing it from collapsing during the ventricular systole.

Apart from imparting a regional support to the part of the heart where it lies, there does not appear to be any other vital function assignable to it.

Department of Zoology, P. L. DUDA.
Univ. of Jammu and Kashmir,
Amarsingh Bagh, Srinagar, Kashmir,
September 19, 1968.

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ON *TRICHOMONAS GALLINAE* (RIVOLTA)—(PROTOZOA: MASTIGOPHORA) FROM THE INDIAN PARIAH KITE

THE parasitic flagellate *Trichomonas gallinae* (Rivolta) Stabler, commonly infesting the upper digestive tract of avian hosts, has been reported from about twenty species of birds (Stabler[4]; Zwart[5]) since its discovery by Rivolta in Italy. Mohteda[2] recorded this parasite from a fowl in Hyderabad Deccan (Andhra Pradesh) India. The object of this note is to place on record this species collected by the author from a new avian host *Milvus migrans govinda* Sykes, commonly known as the Indian Pariah Kite, and to discuss the variations observed in the form occurring in this host.

An examination of the saline smears from the buccal and the anterior region of the oesophagus of a living bird collected from Calcutta City (West Bengal) in November, 1959 revealed the presence of minute pear-shaped bodies jumping about in field of observation. Subsequently, two more birds were collected and examined, but they failed to show any infestation by these parasites. The following observations are mainly based on the study of the expanded specimens fixed in Schaudinn's fluid and stained in Heidenhain's iron-hæmatoxylin. All the measurements given here were taken with the aid of a calibrated ocular micrometer.

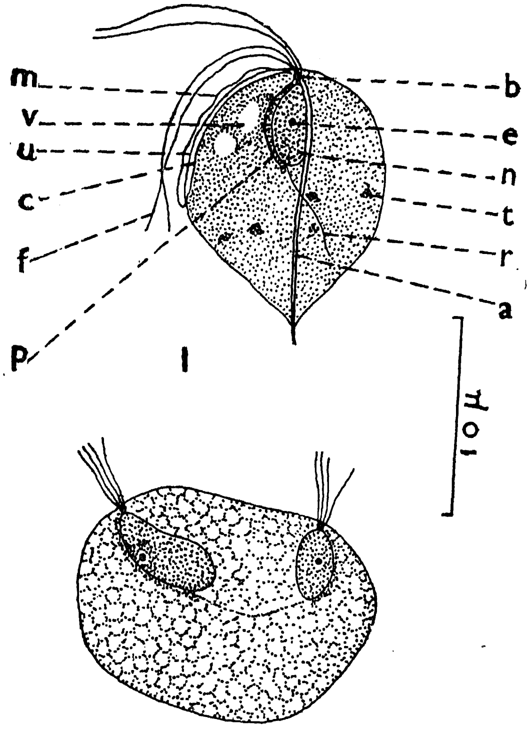
Body pear-shaped; length 9 to 12·5 μ and breadth 4-8 μ, having an average size of 11·5 by 6·5 μ. In the majority of specimens one or two vacuoles are located at the anterior half by the side of the nucleus. The blepharoplast is at the anterior end from which originate four flagella of equal length ranging from 9–10·5 μ. The undulating membrane is very delicate and extends only upto the middle of the body. The membranellar filament stops short at the tip of the membrane. The costa is slender. The axostyle is thin, hollow and projects slightly beyond the body. There is no chromatin at the point of its emergence from the body.

The nucleus is oval-shaped, measuring 4·5 by 2·5 μ, has a central endosome and is located at the anterior third of the body. The parabasal is an elongated '*s*'-shaped body and extends a little beyond the nucleus. A long parabasal fibril (very faintly seen in stained specimens) extends from the parabasal body. The chromatin granules are very few in number.

Taxonomic position.—Class: Mastigophora; Sub-class: Zoomastigia; Order: Trichomonadida; Family: Trichomonadidae Wenyon; Genus: *Trichomonas* Donne' (Classification followed here is based on Kudo[1]).

The size and the structural details of the specimens examined by the author closely resemble and fall within the range of forms known from the other species of avian hosts, especially the ones reported from the American Golden Eagle *Aguila chrysaetos canadensis* (Linnaeus) by Stabler. The notable characters of the forms occurring in the pariah kite are the delicate nature of its undulating membrane presence of vacuoles in the anterior region, presence of a few chromatin granules and the extended parabasal body beyond the nucleus.

This is the first record of this species from the Indian Pariah Kite, *Milvus migrans govinda* Sykes. As no published account has so far been come across in literature of this parasite in this avian host, the author has made a fresh study of the well-preserved specimens to report the findings.



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FIGS. 1–2. *Trichomonas gallinae* (Rivolta). Fig. 1. Form infesting the Indian Pariah Kite (stained specimen). Fig. 2. A dividing individual (stained). *a*, Axostyle; *b* Blepharoplast; *c*, Costa; *e*, Endosome; *f*, Flagellum; *m*, Membranellar filament; *n*, Nucleus; *p*, Parabasal body; *r*, Parabasal fibril; *t*, Chromatin granule; *u*, Undulating membrane; *v*, Vacuole.

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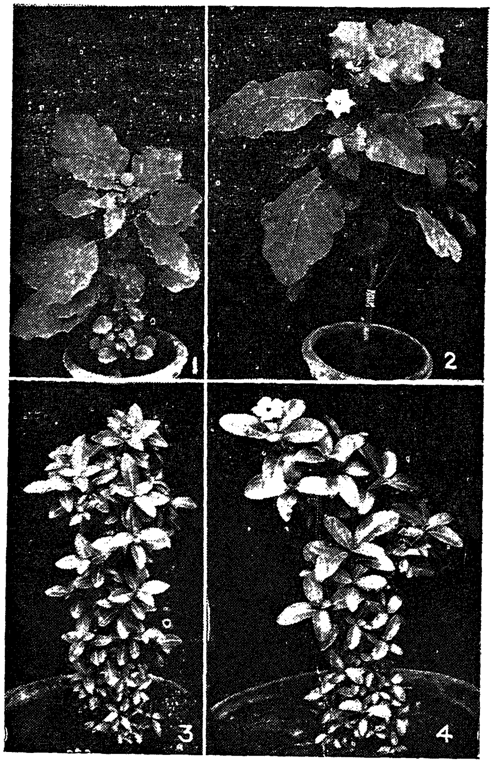
THERAPY OF EGGPLANT LITTLE LEAF DISEASE WITH TETRACYCLINES

THE susceptibility of certain yellows type 'virus' diseases to tetracyclines has been demonstrated recently. Mulberry dwarf disease[4] and aster yellows disease[2] were shown to be arrested by treatment with chlortetracycline hydrochloride and tetracycline hydrochloride. Structures resembling mycoplasma or psittacosis-lymphogranuloma-trachoma (PLT) bodies have also been observed in electron micrographs of thin sections of plant parts affected by mulberry dwarf, potato witches' broom, Japanese aster yellows and paulownia witches' broom[3]; aster yellows and corn stunt[6] and Crimean yellows, European clover dwarf, stolbur and parastolbur.[7] Based on these observations, opinion is gaining ground that these diseases are not caused by viruses but by organisms referred to above.

In an earlier communication,[1] we have established the identity of eggplant little leaf 'virus' with the tomato big bud 'virus' and the tomato stolbur 'virus'. The observations of Ploate *et al.*[7] that the stolbur disease is caused by agents resembling mycoplasma (PPLO), L-forms of bacteria or psittacosis-lymphogranuloma-trachoma induced us to test the effect of tetracyclines on little leaf diseased egg plants and *Vinca rosea.*

Tetracycline hydrochloride (Achromycin), chlortetracycline hydrochloride (Aureomycin) and demethyl-chlortetracycline (Ledermycin) at 500 ppm. were fed through cotton wicks to graft-inoculated eggplants. The antibiotic treatment was started 5 days after inoculation and continued up to the 20th day. Six control plants were fed by the same method with distilled water. The control plants developed symptoms of the disease 22–29 days after inoculation. The plants treated with all the three antibiotics developed symptoms only 40–51 days after inoculation (Figs. 1 and 2).

In experiments with *Vinca rosea,* diseased plants showing severe little leafing and stunting were treated with chlortetracycline hydrochloride at 500 ppm. One set of plants was sprayed with the chemical at 3-day intervals and another set was fed through wicks. Water-treated controls were maintained. In all antibiotic-treated plants, production of new auxillary branches with smalled leaves was stopped two to three weeks after commencement of treatment. Newly developed shoots appeared healthy and bore normal-sized leaves and also healthy flowers (Figs. 3 and 4). Axillary buds in these shoots were dormant.



FIGS. 1–4. Fig. 1. Eggplant untreated control—45 days after graft-inoculation. Fig. 2. Eggplant treated with 500 ppm chlortetracycline—45 days after graft-inoculation. Fig. 3. *Vinca rosea* untreated control—90 days after inoculation. Fig. 4. *Vinca rosea* treated with 500 ppm chlortetracycline—90 days after inoculation and 40 days after commencement of treatment. Spraying with antibiotic was done at three-day intervals.

Maramorosch *et al.*[6] have suggested that amenability to cure by comparatively low temperatures may be another characteristic of plants infected by mycoplasma-like agents. This is illustrated by the fact that aster yellows disease is inactivated by exposures to temperatures of 38°–42° C.[5] We have observed that when fully little leaf diseased *Vinca rosea* plants were exposed to 40° C. for 15 days or 44° C. for 8 days, the disease symptoms were completely reversed.

The present results indicate that the eggplant little leaf disease is probably caused by mycoplasma or psittacosis-lymphogranuloma-trachoma-like agents. Electron micrographic studies to confirm the above results are in progress.

Dept. of Plant Pathology, A. ANJANEYULU.
Agricultural College and K. RAMAKRISHNAN.
Research Institute,
Coimbatore-3, *April* 18, 1969.

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SOME STUDIES ON *GOSSYPIUM* SPECIES AND THEIR F_1 HYBRIDS

1. Alcohol Leaf Extract Coloration

IN certain *Gossypium* species and species hybrids, five main stem leaves were fixed in absolute alcohol for 24 hours for subsequent observations on leaf stomata. An incidental observation reported here is the coloration of the alcohol fixative drawing the pigments from the leaves of the various species and hybrids subsequent to fixation.

G. herbaceum (A_1), *G. arboreum* (A_2), *G. anomalum* (B_1), *G. sturtianum* (C_1), *G. thurberi* (D_1), *G. armourianum* (D_2), *G. klotszchianum* (D_3-1), *G. aridum* (D_4), *G. raimondii* (D_5), *G. gossypioides* (D_6) and *G. stocksii* (E_1) F_1 (*G. arboreum* × *G. raimondii*), F_1 (*G. arboreum* × *G. armourianum*), F_1 (*G. arboreum* × *G. stocksii*) at the diploid level, F_1 (*G. hirsutum* × *G. raimondii*), F_1 (*G. hirsutum* × *G. armourianum*) at the triploid level and *G. hirsutum* race *mariegalante* and *G. barbadense* at the tetraploid [2 (AD)] level were taken for study in the present instance. (Symbols in parenthesis denote the genomes.)

An interesting feature noted was that the leaves of *G. raimondii* gave a very dark brownish-green colour, entirely different from any other species. The same colour was observed in the two hybrids involving this wild species as one of the parents and also in the two tetraploids [2 (AD)]. In no other species or hybrid combination was this characteristic colour evident. *G. anomalum* gave a pale orange coloration while the other species (excepting *raimondii*) were observed to have a pale olive green alcohol coloration.

If the *raimondii* pigment could be observed in the synthesised hybrids having this species as one of the parents at the diploid and triploid level, it is presumed that by the same token of hybridization, the *raimondii* coloration has been imparted to the tetraploids also. The tetraploid cottons (AD genome) are believed to have arisen due to natural hybridisation between the A and D genomes at the diploid level and subsequent spontaneous doubling to form amphidiploids. Of the several D genome species, *G. raimondii* has been suggested as the most likely species to have hybridized with A genome based on morphological, cytological and genetic tests.[1-3]

The observations in the present study also tend to confirm the postulate of the previous investigators that *G. raimondii* is the most likely species to have contributed its genome to the tetraploid cottons.

TABLE I

Sl. No.	Species and crosses	Anther case		Pollen colour	Filaments	Androecium base
		Shape	Colour			
1	*G. arboreum* race *indicum*	Reniform	Yellow	Yellow	Pale yellow	Pale yellow
2	*G. arboreum* race *soudanense*	,,	,,	,,	Red for basal filaments and pale yellow for top filaments	,,
3	*G. hirsutum*	,,	Pale yellow	,,	Pale yellow	,,
4	*G. raimondii*	Horseshoe	Red	Cream	Red	Red
5	*G. armourianum*	Reniform	Orange-yellow	Yellow	Pinkish-white	Orange red
	F_1 (1×4)	Horseshoe	Yellow	,,	Red	Red spots on pale yellow background
	F_1 (3×4)	,,	Pale yellow	,,	,,	Pale yellow
	F_1 (2×5)	Reniform	Orange-yellow	,,	Pinkish-red	Red
	F_1 (3×5)	,,	Pale yellow	,,	Pinkish-white	Orange-red

2. Anther Cases and Colour

In the species of *Gossypium*, the anther cases are generally reniform in shape. Exception to this generality is seen in the wild American diploid species *G. raimondii* Ulb., in which the anther cases are usually the shape of a horseshoe. In hybrids between the wild species as the pollen parent and the cultivated *G. arboreum* (diploid) and *G. hirsutum* (tetraploid), which possess reniform anthers, it has been observed that in the F_1s, the horseshoe shape is dominant over the reniform shape. As the F_1s are sterile, it has not been possible to follow the inheritance further.

The characteristic red pigmentation in the petal spot, filaments and base of androecium is controlled by the R^{RAI} gene in *G. raimondii*.[4] It is not known if this gene is responsible for a similar pigmentation on the anther cases of this species. In the F_1 hybrids mentioned above, the petal spot and the filament pigmentations are expressed very markedly while there is an incomplete expressivity for the androecium base colour. The red anther case colour is not observed in such F_1s.

In *G. armourianum*, the R_1^{ARM} gene controls the petal spot.[5] Again, there is no information available if this gene is responsible for the orange-red androecium base colour and organge-yellow anther case colour in this species. In F_1 hybrids, between this species as the male parent and the cultigens mentioned above, the petal spot and androecium base pigmentations are dominant in hybrids with *G. hirsutum*, while the anther case colour is recessive and with *G. arboreum*, all the three characters are expressed fully.

The data are as in Table I.

From the observations, it would appear that the horseshoe shape of the anther cases in *raimondii* may be under the influence of a gene (or genes) as this shape is markedly dominant over reniform shape in F_1s with the cultigens.

The 'R' locus-controlling pigmentation on the anther cases in the wild species would seem to be incapable of expressing the colour, when transferred to the cultigen background except in the case of *arboreum-armourianum* hybrid. The varied aspect, in the expression of anther case colour alone, is suggestive of an independent gene control for this character.

The author is grateful to Dr. J. E. Endrizzi, Head of Plant Breeding Department, University of Arizona, Tucson, U.S.A., for his valuable suggestions and help in preparing this note.

Agricultural College MANOHAR BAHAVANDOSS.
and Research Institute,
Coimbatore-3, *January* 28, 1969.

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A NEW BACTERIAL DISEASE OF *BIOPHYTUM SENSITIVUM*

Biophytum sensitivum (L) D.C., a member of the Geraniaceæ, is found commonly growing in fields during rainy season. In September-October 1967, a leaf spot disease was noticed on this plant at Machhad near Navsari, Gujarat State. The morphological, cultural and physiological characteristics of the pathogen showed it to belong to the genus *Xanthomonas*. Similar disease on two other members of Geraniaceæ, *viz.*, on *Pelargonium* sp. by *X. pelargonii* (Brown) Starr and Burkh. and on *Geranium* sp. by *X. geranii* (Burkh.) Dowson has been reported.[1,2] *B. sensitivum* appears to be the third member of this family to show an infection by *Xanthomonas*.

The disease at first appears as minute water-soaked spots, round to irregular, measuring 1 to 3 mm. in diameter. They are mostly hypophyllous but are also found at the leaf margin which in severe cases cause blighting of the leaf. The pathogen seems to enter through stomata and hydathodes.

The causal organism was isolated on PDA and M_2 media. On inoculation of the young and mature plants of *B. sensitivum* the typical symptoms developed in about 15 days. The pathogen reisolated was identical with the original.

By artificial inoculation, the pathogen could not infect *Tamarindus indica* L., *Lawsonia alba* L., *Triticum vulgare* H., *Sorghum vulgare* P., *Capsicum annuum* L., *Vigna catjang* W., *Cajanus cajan* M., *Ricinus communis* L., *Vernonia cinerea* L., *Carissa carandus* L., *Bauhinia racemosa* L., *Clerodendron phlomides* L., *Phaseolus* sp., *Gossypium* sp., which are found in the vicinity and from which *Xanthomonas* disease was reported. *Averrhoa carambola* L., *Oxalis corniculata* L., and *Impatiens blasamina* H., which belong to Geraniaceæ, could not be infected by the pathogen under study.

Since no bacterial disease is reported from the host *B. sensitivum*, and the pathogen isolated differs from *X. pelargonii* and *X. geranii* in some of the characteristics and its host range, it is, therefore, proposed to assign a new name *Xanthomonas biophytii* nov. sp. to this pathogen. The technical description of the pathogen is as follows:

Xanthomonas biophytii Nov. Sp.

Short rods with rounded ends, usually single, rarely in pair, measuring 1–1·7 × 0·5–0·7 microns, gram-negative, motile with polar flagellum, capsulated, no endospore, non-acid-fast, colonies on PDA plate—big circular, smooth surface and entire margin, butyrous and glistening yellow. Growth on PDA slant is abundant, filiform, convex, smooth, opaque, butyrous and glistening yellow, medium remains unchanged. On nutrient agar growth is moderate, filiform, flat, smooth, opaque and glistening yellow.

Starch hydrolysed, casein digested, tributyrin hydrolysed, gelatin liquefied and hydrolysed, milk peptonised and litmus reduced, nitrates not reduced to nitrites, ammonia and hydrogen sulphide produced, indol not produced, V.P. and M.R. tests negative, uric acid utilised but not citrate, tolerates 3% sodium chloride but not 5%, acid without gas from maltose, glucose, lactose, sucrose, arobinose, fructose, mannose, inuline, cellobiose, galactose, but no acid and no gas from mannitol, xylose, raffinose, rhamnose, sorbitol, inocitol, dulcitol, glycogen, glycerol and salicin. Catalase positive, aerobic, optimum temperature 27°–31° C., thermal death point 53° C.

Pathogenic only to *B. sensitivum* producing spots as well as blighting symptoms on leaves.

Thanks are due to Rev. Fr. H. Santapau, Director, Botanical Survey of India, for suggesting the Latin name for the pathogen and to Principal P. B. Menon, Baria Science Institute, Navsari, for his interest in the present work.

Microbiology Department, A. M. Patel.
B.P. Baria Science Inst., J. M. Chauhan.
Navsari, Gujarat, India, W. V. Kotasthane.
and
Department of Plant M. V. Desai.
Pathology and Bacteriology,
B.A. Agriculture College,
Anand, Gujarat (India),
April 27, 1968.

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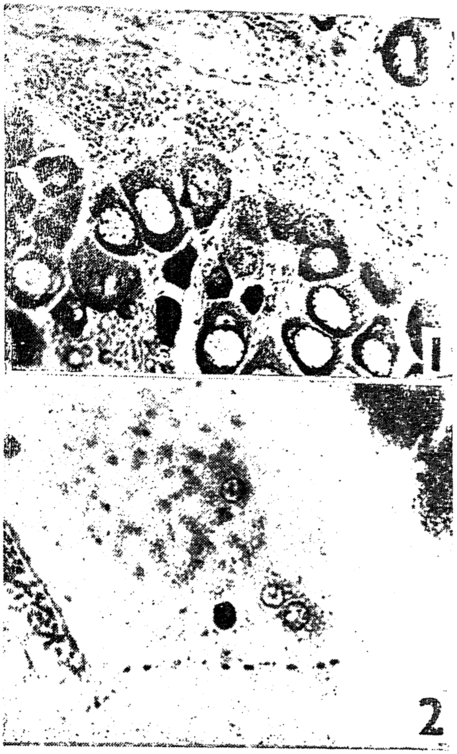
ORIGIN OF NEW CROP OF OOCYTES IN THE TELEOST, *ANABAS SCANDENS* (CUVIER)

The opinion with regard to the origin of new crop of oocytes is diverse and controversial.[1,2] In immature specimens of *Anabas scandens* measuring 5-8 cm. in length a considerable number of small undifferentiated cells are found proliferated from the germinal epithelium (Fig. 1). These cells, as has been reported for *Phoxinus*,[3] *Oryzias*[4] and *Gobius*,[2] are identical to those differentiated from the germinal epithelium of spent ovaries of adult *Anabas*. Their cell-boundary is indistinct; their nuclei are slightly irregular and each of them occupies almost the entire space of the respective cell. These undifferentiated cells soon divide mitotically to give rise to oogonial cells. In addition to these, some oogonial cells are also noticed differentiating occasionally from the remnants of the follicle cells of the preovulatory corpus luteum (Fig. 2). Some of the oogonia derived either from the germinal epithelium of immature fish or from that of the spent one, after a period of rapid growth and differentiation, develop into fully grown functional eggs while the rest become atretic. Whether or not the oogonia differentiated from the follicle cells of preovulatory corpus luteum develop into mature functional eggs needs further investigation. At any rate, the occurrence of the dual origin of oogonia in the ovary of *Anabas* appears to be interesting.



FIGS. 1-2. Fig. 1. Section of the ovary from an immature specimen showing small cells proliferated from the germinal epithelium. Bouin's fluid, 8 μ, iron hæmatoxylin eosin, × 500. Fig. 2. Section of atretic oocyte showing the differentiation of oogonial cells from the remnants of the follicular cells. Bouin's fluid, 8 μ, iron hæmatoxylin × 860.

Our thanks are due to Dr. Vijayam Sriramulu and Shri Ramakrishna Raju for their help in photomicrography. One of us (N. H. G. D.) is grateful to the Ministry of Education, for a Senior Research Scholarship.

Department of Zoology, N. H. Gopal Dutt.*
Annamalai University, P. Govindan.
Annamalainagar,
September 9, 1968.

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* Present address: Lecturer, Department of Zoology, University of Mysore, Mysore-6.

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REVIEWS AND NOTICES OF BOOKS

Reduction: Techniques and Applications in Organic Synthesis. Edited by Robert L. Augustine. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. ix + 242. Price $ 12.75.

It has become difficult for the practising organic chemist to be aware of all the applications of a given reaction and to select the conditions which are suitable for each particular application. This series provides, in separate volumes, concise and critical evaluations of important reactions in organic synthesis. Each volume deals with a single operation (hydrogenation, reduction, oxidation, etc.), so that information on all aspects of the area is readily available.

This book contains comprehensive discussions of techniques and applications of reduction in organic synthesis. The chemistry of the mixed hydrides, the dissolving metal reductions, and the deoxygenation of carbonyl compounds are the major topics discussed. Specific recommendations as to the most general or applicable experimental procedures are presented in bold-faced type. Mechanistic considerations are included in the discussions primarily in order to enhance the understanding of the particular reactions.

The titles of the chapters contained in this book are: The Chemistry of the Mixed Hydrides, by Mark N. Rerick; Dissolving Metal Reductions, by Michael Smith; Deoxygenation of Carbonyl Compounds, by William Reusch.

C. V. R.

The Bond to Carbon (*Organometallic Compounds of the Group IV Elements*, Volume 1, *Part II*). Edited by Alan G. MacDiarmid. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xiii + 261. Price $ 17.75.

The great increase of interest during recent years in those organic compounds of the group IV elements (silicon, germanium, tin, and lead) which contain at least one group IV element—carbon bond has paralleled the overall growth of the whole field of organometallic chemistry. In many cases the volume of literature dealing with the organometallic chemistry of even a single element is increasing so rapidly that a person interested in this area is faced with the growing danger of becoming relatively isolated within his own small field—be it organo-silicon, -germanium, -tin, or -lead chemistry or the organic chemistry of any other element.

The series *Organometallic Compounds of the Group IV Elements* helps to counteract this tendency toward "isolationism" by presenting a summary of the organometallic chemistry of the group IV elements.

Volume 1 (in two parts) of the series is entitled, *The Bond to Carbon*. Chapter 1 of Part I presents an overall coverage of the physical basis of the chemistry of the group IV elements, giving the reader a general bird's eye-view of many factors which are important in shaping the chemistry or structure of these elements and their compounds. Electron configuration, bond lengths, angles, and energies, and the role of *pi* bonding and *d* orbital effects in determining certain physical or chemical properties of compounds are among the aspects examined. Chapter 2 includes a full discussion of the synthesis and reactions of the silicon—carbon bond.

Part II under review covers in considerable detail the synthesis and properties of the germanium—carbon, the tin—carbon, and the lead—carbon bond.

C. V. R.

Starch and Its Derivatives. Fourth edition. by J. A. Radley. (Chapman and Hall Ltd., 11 New Fetter Lane, London EC. 4), 1968. Pp. viii + 558. Price 140 shillings.

Since the first edition, in 1940, "Radley" has been the standard work of reference on all starch chemistry and technology. Fifteen years have elapsed since the last (third) edition appeared and, during that time, there have been many advances in our understanding of the structure and chemistry of starch. All this new knowledge influences the methods of separation of starch from raw materials and the technology of the many industries which use starch. The edition under review discusses the basic chemistry which formed Volume I of the Third Edition, and will therefore be essential to anyone wanting information about starch. This work is documented with numerous references, The contents of this book are dealt with in two parts, viz., Part I: The Structure and Reaction of Starch and Part II: Amylases and Their Action on Starch.

Part I contains the following articles: General Survey of Starch Chemistry to 1950; The Biological Synthesis of Starch; The Chemical Evidence for the Structure of Starch; The Structure of the Starch Grain; Swelling and Gelation of Starch; Starch Retrogradation; The Reaction of Starch with Lodine; Waxy Cereals and Red Iodine Starches; Dextrins and Dextrinization; The Schardinger Dextrins; The oxidation of Starch; The Starch Esters and Ethers.

Part II contains the following articles: General; The α-amylases; The β-amylases; Amyloglucosidase; Pullulanase. C. V. R.

Advances in Chromatography (Vol. 7). Edited by J. Calvin Giddings and Roy A. Keller. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xviii + 313. Price $ 15.75.

Volume 7 of this well-known series contains the following articles: *General Chromatography*: 1. Theory and Mechanisms of Gel Permeation Chromatography, by K. H. Altgelt; 2. Thin-Layer Chromatography of Nucleic Acid Bases, Nucleosides, Nucleotides, and Related Compounds, by Gyorgy Pataki; 3. Review of Current and Future Trends in Paper Chromatography, by V. C. Weaver; 4. Chromatography of Inorganic Ions, by G. Nickless. *Gas Chromatography*: 1. Process Control by Gas Chromatography, by I. G. McWilliam; 2. Pyrolysis Gas Chromatography of Involatile Substances, by S. G. Perry; and 3. Labelling by Exchange on Chromatographic Columns, by Horst Elias.

C. V. R.

British Medical Bulletin: Computing in Medicine (Vol. 24, Number 3). Scientific Editor C. C. Spicer. (Medical Department, The British Council, 65, Davies Street, London W. 1), September 1968. Pp. 90. Price £ 2.

This publication contains the following articles: Introduction; Computer Technology; Medical Vocabulary and Information; Preparation of Clinical Data for Computers; Linkage of Medical Records; Disciplining of Medical Data; Computer Surveillance of Congenital Malformations; Computer Science in the Biochemistry Laboratory; Computer Diagnosis: Clinical Aspects; Computer Diagnosis: Statistical Aspects; Medical Applications of Taxonomic Methods; A Brief Note on Computer Applications in Radiotherapy; Computers in Radiobiology; Computer Simulation of Respiratory Physiology; Computing Techniques in Neurological Diagnosis; and Automatic Chromosome Analysis. C. V. R.

Scientific Research in British Universities and Colleges, 1967-68 (Vol. I). Physical Sciences. [Department of Education and Science, and the British Council (HMSO).] Pp. 560. Price 45 *sh*.

This annual publication sponsored by Britain's Department of Education and Science, and the British Council is intended to provide brief notes on research studies undertaken and in progress in British Universities and other institutions. The volume under reference is for the year 1967-68 on Physical Sciences. For the purpose of compilation, the subject is divided into 40 broad fields of research and the Universities and Institutions, 147 in all, are numerically coded alphabetically. Under each subject field the material is arranged according to institutions, and under each institution the names of professors and research staff are given, and against each name the topic of research. A name index of 80 pages will help to find who is doing *what* and *where*, and a subject index of 50 pages will help to find *where* the particular problem is being worked and by *whom*.

Besides its general use to research workers to contact their colleagues working in the same field, the publication will be of special help to Commonwealth students intending to go for research studies to Britain. A. S. G.

Books Received

Mass Spectrometry. By R. Brymner and J. R. Penney. (Butterworth and Co. Pub. Ltd., London W.C. 2), 1968. Pp. ix + 275. Price 80 *sh*.

Experiments in Microbial Genetics. Edited by R. C. Clowes and W. Hayes. (Blackell Scientific Publishing Oxford, England), 1968. Pp. xii + 244. Price 42 *sh*.

Biology Introduction to Life. By A. Nason and P. Goldstein. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1), 1969. Pp. ix + 780. Price 65 *sh*.

Phosphoric Acid (Vol. I, Part II). Edited by A. V. Slack. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), Pp. xvi + 1159. Price $ 42.50.

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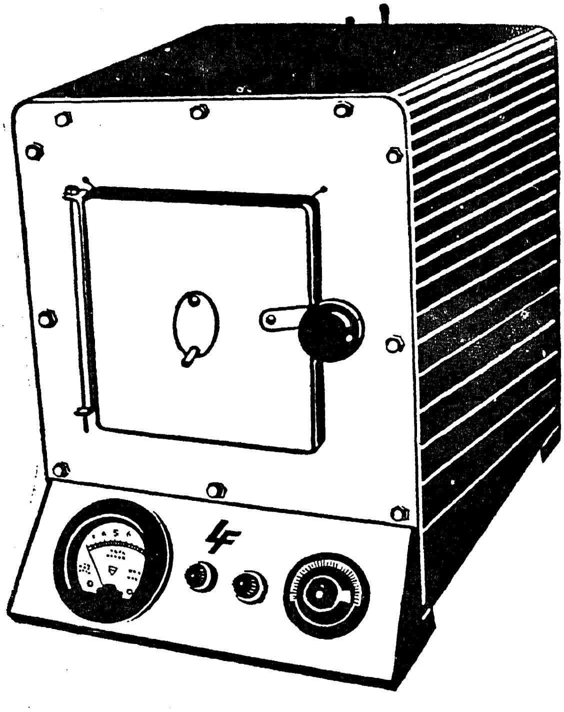

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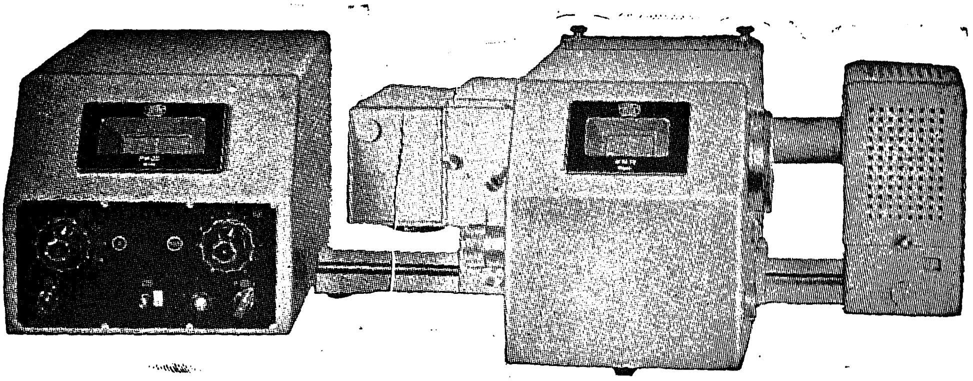

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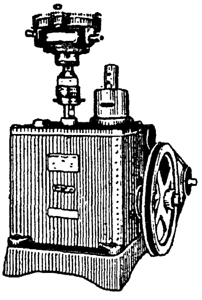

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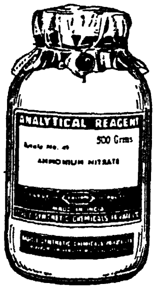

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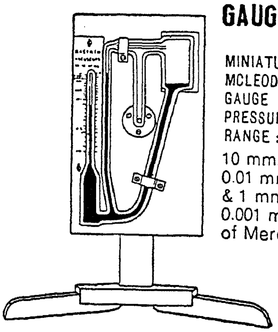

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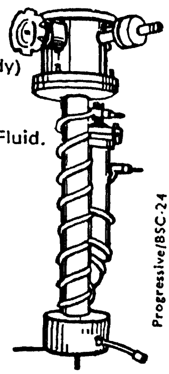

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MICRODETERMINATION OF ZIRCONIUM IN MARINE ENVIRONMENT*

V. N. SASTRY, T. M. KRISHNAMOORTHY AND T. P. SARMA
Health Physics Division, Bhabha Atomic Research Centre, Bombay-85

As Cs-137, Sr-90, Ru 106, Ce 144 and Zr-95-Nb-95 are produced in high yields in fission and appear as contaminants in marine environment, it is necessary to know the fate of these nuclides so as to limit their discharges into the sea. Mauchline and Templeton[1] summarised the work done on the distribution of Zr in the various matrices of marine environment. Mauchline[2] has determined the Zr-95 activity in sea-water, algae, fishes and invertebrates arising out of discharges from Windscale nuclear installations. It is generally believed that Zr is effectively removed from sea-water by adsorption on the surfaces of fine particles such as silt.[2] Foreman and Templeton[3] studied the uptake of Zr-95 activity on *Prophyra* sp. (algae) and using autoradiography technique, they concluded that Zr is taken up mostly by adsorption. Most of the work carried out so far is on the distribution of Zr-95 in the marine environment and the methods adopted are different for different matrices. It is the objective of this investigation to develop a uniform method for the estimation of Zr in the various matrices of marine environment, *viz.*, sea-water, sediment and biological species.

Sea-water and sediment samples were collected from Tarapur region (Lat. 19° 45′ N., Long. 72° 36′ E.) about 2-3 Km. off-shore during 1966-67. Most of the biological samples were collected from nearby region except one sample, *Meretrix meretrix* from Ratnagiri region (Lat. 17° 08′ N., Long. 73° 30′ E.).

Sediment samples are dried at 105-110° C. A known amount of the dried sample is leached with N/20 HCl, 5% EDTA, 1 N ammonium citrate and 1 N ammonium acetate as described by Sarma *et al.*[4] The leaches are evaporated to dryness and muffled at 500° C. to destroy the organic matter and then taken up in 10 N HCl. Biological samples are also dry-ashed at 500° C. and then taken up in 10 N HCl.

The acid-soluble part of the biological and sediment leaches are oxidised with 0·5 g. of $KBrO_3$ to convert Fe to Fe and centrifuged to remove silica. The clear solution is then passed through Dowex-1 anion exchange resin previously conditioned with 10 N HCl. 2-3 column volumes of 10 N HCl are used for washing the column. Elements such as Ca, Mg, Al, Th, etc., are not adsorbed on the column at this acidity. Zr is held on the column along with Fe^{+3}, U^{+6}, Cr^{+6}, and small amounts of cobalt and titanium. The column is eluted with 6 N HCl to desorb Zr. Small amounts of Co and Ti also accompany the Zr fraction. Tests have been made on the recovery of Zr at 6 N and 4 N HCl concentration of the leach. Even though, the recovery of Zr at 4 N HCl concentration is close to 100%, elution with 6 N HCl is preferred (recovery 80-85%) in order to avoid the contamination from Co. The Zr fraction was evaporated to dryness, converted to nitrate by treating with conc. HNO_3 twice and evaporating to dryness. The residue is taken up with 50 ml. of 5 N HNO_3 and 10 mg. of cerium carrier (sulphate form) is added. Cerium was precipitated as ceric iodate by adding 50 ml. of 0·35 M potassium iodate. Experiments were carried out to see the co-precipitation of Zr on ceric iodate and found to be 80-85%. Care is taken to avoid even traces of chloride in the solution, as chloride ion reduces ceric to cerous. The iodate precipitate is kept for 2-3 hrs. and centrifuged. The precipitate is taken up in 10 ml. of 4 N HCl and evaporated to dryness. Decomposition of ceric iodate by HCl is continued till no iodine vapours appeared. The residue is taken up in 10 ml. of 4 N HCl and 2 ml. of 0·25% Alizarin Red-S (in aqueous form) is added. The solution is made slightly alkaline with dilute ammonia. After 2-3 minutes, dilute HCl is added drop by drop till it is neutral, followed by 1·75 ml. of conc. HCl and the volume is made up to 50 ml. (overall acidity 0·4 N). The absorbance of the Zr lake is measured at 560 mμ. Experiments have been carried out to see the overall recovery of Zr by the above procedure.

About 60 litres of sea-water is filtered through Whatman No. 42 filter-paper and the pH is adjusted to about 2 with HCl. About 0·5 g. of iron carrier is added and precipitated as hydroxide with ammonium hydroxide to carry down Zr. The hydroxide precipitate is

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*This work is carried out under IAEA/BARC Research Agreement No. 155/R3/CI.

dissolved in conc. HCl and the above procedure is followed. A known amount of Zr is added to 60 litres of artificial sea-water and the recovery of Zr by the above procedure is determined and found to be 25–30%.

As the recoveries were low, experiments were conducted to see the collecting efficiency of ferric hydroxide for Zr. 500 ml. of sea-water was spiked with Zr-95 and acidified with HCl to pH 2. 15 mg. of Fe^{+3} (as nitrate) was added and the hydroxide precipitated with ammonia. The precipitate was centrifuged and planchetted. It was counted for Zr-95 betas using an aluminum absorber of 27 mg./cm.^{2} thickness to cut off Nb-95 betas. The standard and the sample were counted under identical geometry conditions. The collecting efficiency of ferric hydroxide for Zr is found to range from 60–70% even in small volumes of sea-water of 500 ml. (Table I).

TABLE I

Collecting efficiency of ferric hydroxide for zirconium

No.	Activity of Zr-95*		Recovery %
	added cpm	obtained cpm	
1	854	593	69·4
2	854	570	66·8
3	794	500	63 0
4	794	480	60·5
5	794	490	61·7

* Nb-95 betas were cut off by using 27 mg./cm.^{2} Al absorber.

50–250 µg. of Zr is taken and the colour is developed with the aqueous form of Alizarin Red-S. The volume is made up to 50 ml. with an overall acidity of 0·4 N. The absorbances are measured at 520 mµ and 560 mµ and the calibration curves are given in Fig. 1. Actual measurement of the samples is done at 560 mµ even though the absorbance of Zr lake at 520 mµ is high, in order to avoid higher blanks. 10 mg. of cerium do not show any interference in the estimations of Zr and small amounts of Th present in the samples are completely removed in ion-exchange step.

50–250 µg. of Zr is added to a 50 ml. solution of Fe^{+3} (as chloride) containing 50 mg. of iron in 10 N HCl and taken through the entire procedure, given above, in order to see the overall recovery of Zr at various concentrations and these results are given in Table II. As seen from this table, the overall recovery of Zr is 60 ± 5%. Better results are obtained if the Zr concentrations is above 1 µg./ml. The results of analysis of sea-water, sediment and biological samples are given in Table III. Mauchline and Templeton[1] reported a value of 0·2 ppm. of Zr in sea-water whereas our values are in the range of $0 \cdot 42 \times 10^{-3}$ to $1 \cdot 44 \times 10^{-3}$ ppm. According to the above authors, most of Zr is in particulate form and they determined Zr in the total sea-water whereas we analysed in the filtered sea-water. There is also a significant difference between post-monsoon and pre-monsoon values. Out of the biological samples analysed, only *Aplysia* sp. (sea-hare) is showing a high enrichment factor of 700 whereas the fishes are showing around 80–150. The labile part of Zr in the various sediment leaches is very high (enrichment factor 2,500–16,000) as obtained from the various leach values. From the above observations, it appears that a good part of Zr entering the seas finds its way into the sediments rather than in the biological species.

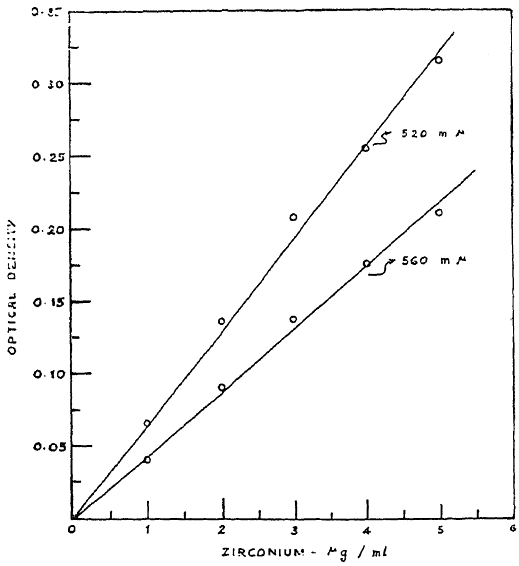

FIG. 1. Calibration of zirconium.

TABLE II

Recovery of zirconium at various concentrations

No.	Zirconium µg./m.	Optical Density		Recovery %
		added	obtained	
1	1	0·041	0·022	54
2	2	0·082	0·052	63
3	3	0·123	0·075	61
4	4	0·164	0·101	61
5	5	0·205	0·133	65

TABLE III

Zirconium content in the various matrices of marine environment

No.	Sample		Location		Zirconium content ppm
1	Sea water	..	Tarapur	(Pre-monsoon)	$1 \cdot 44 \times 10^{-3}$
2	Sea water	..	,,	(Post-monsoon)	$0 \cdot 44 \times 10^{-3}$
3	*HCl leach of sediment	..	,,	(Post monsoon)	2·10
4	*EDTA leach of sediment	..	,,	(Post-monsoon)	7·88
5	*Amm. cit. leach of sediment	..	,,	(Post-monsoon)	2·73
6	*Amm. acet. leach of sediment	..	,,	(Post-monsoon)	1·21
7	*Aplysia* sp. (sea hare)	..	,,	(Pre-monsoon)	1·17
8	*Pampus* sp. (pomfret)	..	,	(Pre-monsoon)	0·14
9	*Otolithus brunneus* (Koth)	..	,,	(Post monsoon)	0·06
10	*Meretrix meretrix* (Clam.)	..	Ratnagiri	(Post-monsoon)	0·07

* Average of 4 sediment leaches. Values of biological samples are expressed on wet weight basis.

We wish to express our deep appreciation to Dr. A. K. Ganguly, Head, Health Physics Division, Bhabha Atomic Research Centre, for initiating the work and his continued interest.

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THIRD INTERNATIONAL SYMPOSIUM ON EQUATORIAL AERONOMY

RECOGNISING the increasing activity of Indian scientists in the study of the earth's atmosphere and its environs, a number of working scientists in the fields of geomagnetism and aeronomy proposed that the Third Symposium on Equatorial Aeronomy be held in India. The first Symposium was held in Peru in 1962, and the second at Sao Paulo in Brazil in 1965.

The Department of Atomic Energy provided financial support to the Physical Research Laboratory (PRL) at Ahmedabad for conducting the symposium. Besides, Radio Science (URSI), the International Association of Geomagnetism and Aeronomy (IAGA) and the Inter-Union Commission of Solar Terrestrial Physics (ICUSTP) sponsored the symposium.

The symposium was held at Ahmedabad from the 3rd to the 8th February 1969. Nearly 70 scientists from nineteen foreign countries and 100 scientists from India participated in the symposium. Professor Sydney Chapman, the doyen of Aeronomy and Geomagnetism, inaugurated the symposium and Dr. Vikram A. Sarabhai gave the welcome address.

The symposium discussed the following topics: The D-region at Low Latitudes: Ionospheric Absorption; Irregularities in the Equatorial Electrojet; Dynamo Currents and Electric Fields. The Neutral Atmosphere at Low Latitudes; Ionospheric Irregularities; Equatorial F-region; Total Electron Content; Air Glow; Neutral Particles and Ion-Chemistry; Dynamics of F-region; Ionospheric and Geomagnetic Tides; Magnetic and Ionospheric Storm-phenomena in the Equatorial Region; Exospheric Whistlers; Micropulsations; Magnetosphere and Solar-Terrestrial Relationships. Besides the formal sessions, there were many group discussions, informal discussions, lectures and visits.

An illustrated *Abstracts* will be published to bring together the main ideas and results exchanged during the course of the symposium.

P. R. PISHAROTY.

INFLUENCE OF THE PESTICIDE MALATHION ON GROUNDNUT (*ARACHIS HYPOGEA* L.) MICROFLORA*

R. SWAMINATHAN AND S. B. SULLIA
University Botany Laboratory, Madras-5

THERE has been great expansion in the use of chemicals of high biological activity for pest control in recent years. Biologists are now aware of the harmful effects of indiscriminate use of pesticidal chemicals. In addition to their toxicities to a wide range of animals including man, some of them have proved to be phytotoxic, affecting chlorophyll synthesis, nucleic acid metabolism and other metabolic activities.[2,4–7,10–12] Very little is, however, known about the toxicities of many of the pesticides to the soil microflora. The normal balance of microbial population in the soil is invariably upset due to treatments by pesticides which persist in soil.[1,3,8] The pesticide malathion which has low toxicity to animals and man compared to parathion is widely used all over the country on several crops and on groundnut it is particularly used to control the red hairy caterpillar and aphids. Malathion is stable even on exposure to light and moderately high temperatures. The purpose of this investigation was to explore the effects of malathion spray on the rhizosphere microbiology of groundnut plants under field conditions.

Commercial liquid malathion (0, 0-dimethyl phosphorodithioate of diethyl mercaptosuccinate) was used in three dilutions, *viz.*, 1 : 400, 1 : 500 and 1 : 600. Seedlings of *Arachis hypogea* L., var. TMV-2 were raised in four uniform plots 6′ × 6′ size at the University Farm and Field Laboratory at Maduravoyal. One of the plots was used as control while the other three for treatments. Five sprays of the pesticide were given at intervals of 15 days, 1000 ml. of the pesticide being administered per plot each time. Equal volume of distilled water was sprayed on the control plot. Rhizosphere samples were taken 48 hr. after each spray and plated separately for fungi, actinomycetes and bacteria by the dilution plate method. The media used were Martin's medium for fungi,[9] KenKnight's agar medium for actinomycetes [glucose—1 g.; $MgSO_4 . 7H_2O$—0·1 g.; KCl—0·1 g.; $(NH_4)_2SO_4$—0·1 g.; KH_2PO_4—0·1 g.; agar—15 g.; distilled water—1000 ml.] and nutrient agar medium for bacteria (peptone—5 g.; glucose—5 g.; beef extract—3 g.; sodium chloride—5 g.; agar—15 g.; distilled water—1000 ml.).

The bacterial and actinomycete populations showed significant changes following malathion spray while fungal population did not. The bacterial numbers decreased steadily upto the third spray and then remained constant at a level much lower than the control (Table I). The total actinomycete population showed a steady increase over the control (Table I). The maximum actinomycete population was from the plot receiving lowest concentration of the chemical and the minimum from plot having highest concentration.

TABLE I

Number of micro-organisms per gram of groundnut rhizosphere after malathion spray (CL—Control; M 1, M 2 and M 3—malathion dilutions—1 : 600; 1 : 500 and 1 : 004)

Date of sampling	Age of plants in days	Fungi (× 10^4)				Bacteria (× 10^6)				Actinomycetes (× 10^6)			
		CL	M 1	M 2	M 3	CL	M 1	M 2	M 3	CL	M 1	M 2	M 3
14- 9-1968	30	2·4	2·6	4·8	1·9	7·26	10·81	7·34	6·68	0·99	1·72	1·87	1·23
29- 9-1968	45	7·1	5·0	4·2	3·5	7·14	7·98	6·08	4·64	1·24	2·29	2·28	1·92
14-10-1968	60	1·3	2·0	2·5	2·4	6·91	6·34	4·00	2·26	1·50	2·74	2·44	2·49
29-10-1968	75	2·2	1·5	1·8	4·2	6·88	6·30	3·96	2·23	1·51	2·72	2·44	2·46
13-11-1968	90	2·8	0·6	1·2	6·4	6·68	6·12	3·77	1·99	1·38	2·47	2·19	2·28

Statistical analysis by F Test:

Micro-organisms	Comparison between	Level of significance
Fungi	Control *vs.* treated	Insignificant
Bacteria	do.	5%
Actinomycetes	do.	1%

---

* Memoir No. 73 from the Centre for Advanced Studies in Botany.

The numbers of antibacterial and antifungal actinomycetes were determined after each spray by cross-streaking each isolate against bacterial pathogens and saprophytes and fungal pathogens and saprophytes, *viz.*, *Xanthomonas malvacearum*, *X. oryzæ*, *Pseudomonas* sp., *Rhizobium* sp., *Bacillus subtilis*, *Azotobacter* sp., *Fusarium* sp., *Alternaria* sp., *Aspergillus* sp., and *Penicillium* sp. The results showed an increase in the number of antibacterial actinomycetes following spray (Table II). This increase in the antibacterial actinomycete population seems to be responsible for the decrease in the bacterial population. However, there was no correlation between the number of antifungal actinomycetes and the total number of fungi isolated as generally the number of antifungal actinomycetes was very low, not more than 2% of the total isolates (Table II).

TABLE II

Percentage of antagonistic actinomycetes to the total actinomycete isolates from groundnut rhizosphere after malathion spray (CL—control; M 1, M 2 and M 3—malathion concentrations—1 : 600 ; 1 : 500 and 1 : 400)

Date of sampling	Age of plants in days	Antibacterial				Antifungal			
		CL	M 1	M 2	M 3	CL	M 1	M 2	M 3
14-9-1968	30	0·60	2·00	1·00	1·5	1·0	1·7	1·3	1·1
29-9-1968	45	0·75	5·00	6·00	3·0	0·8	2·0	1·9	1·4
14-10-1968	60	0·75	9·00	5·75	4·75	0·9	2·0	1·9	1·5
29-10-1968	75	0·75	8·75	5·50	4·50	0·9	2·0	1·9	1·4
13-11-1968	90	0·75	8·50	5·25	4·25	0·9	2·0	1·8	1·4

To ascertain whether the reported population changes were conditioned by the root exudates, plants were grown under aseptic conditions and treated with the same concentrations of the pesticide used in the field and their root exudates assayed as follows: Seeds, surface-sterilized with 0·1% mercuric chloride, were transferred to sterilized Roux tubes containing sterile Pfeffer's solution and a filter-paper cone to support the seeds and keep them moist. The tubes were plugged with sterile cotton and kept for 13 days in bright diffused light after which the plants were transferred to 250 ml. conical flasks containing 200 ml. of sterile 10-times diluted Pfeffer's solution. The plants were held in position by sterile cotton plugs to prevent contamination of the root region of plants while the top was exposed. After 48 hours in these flasks, the leaves were sprayed with the three pesticide dilutions, the control plants being sprayed with distilled water. The liquid in the flasks along with the root exudates was drained into sterile flasks 48 hrs. after spraying. This liquid was incorporated into agar media. A sample of soil taken from the control plot was plated on these media by dilution plate method. The basic media used for the isolation of fungi, actinomycetes and bacteria were the same as mentioned before. The number of micro-organisms per gram of soil isolated on media with root exudates from pesticide-treated plants and controls are given in Table III. There was definite decrease in the number of bacteria over the control in agar media with exudates from treated plants. The actinomycete population, on the other hand, showed an increase over the control. The number of fungi did not show variation between the different treatments and control. This data corresponds with the data obtained from isolations from field after spray.

TABLE III

Number of micro-organisms isolated from control plot soil on media treated with root exudates of malathion sprayed and control plants (numbers per gram of soil × 10^6)

Micro-organisms	CL	M 1	M 2	M 3
Fungi ..	0·031	0·031	0·033	0·032
Bacteria ..	8·73	7·42	7·62	6·98
Actinomycetes ..	1·60	2·42	2·86	3·20

CL = media with root exudate from control plants.

M1, M 2 and M 3 = media with root exudates from plants treated with malathion of dilution 1 : 600, 1 : 500 and 1 : 400 respectively.

The above data indicate that malathion influences bacterial and actinomycete populations of the rhizosphere of groundnut while being ineffective on the fungal population in the experiments reported here. Also, this *in vitro* study shows that the action of the pesticide in changing the microbial pattern is dependent on root exudations and is comparable to observations made under field conditions. The implications of these results can be better understood if the effects of the chemical directly or indirectly on plant metabolism are studied alongside rhizosphere microbial ecology.

The authors are indebted to Prof. T. S. Sadasivan for useful discussions and to the University of Madras for the award of Senior Research Fellowships.

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CHEMICAL COMPONENTS OF *ENHYDRA FLUCTUANS*—II

N. R. KRISHNASWAMY,* T. R. SESHADRI AND T. N. C. VEDANTHAM

Department of Chemistry, University of Delhi, Delhi-7

IN an earlier communication,[1] we reported the isolation and preliminary study of a new sesquiterpene lactone, named enhydrin from a petroleum ether extract of *Enhydra fluctuans*, a plant used in India as drug. We now report some further observations on enhydrin and on another new component of the plant. Our experience is that the yields of these compounds are poor and vary from batch to batch of the material.

As stated earlier,[1] enhydrin has the molecular formula $C_{23}H_{28}O_{10}$. The presence of $\alpha:\beta$-unsaturated γ-lactone inferred earlier from i.r. and nmr spectral data is further supported by the following observations. Enhydrin answers the Legal test (*cf.* Mexicanin A) and reduces Tollen's reagent. Using a better instrument, a careful recording of its uv spectrum in ethanol below 220 mμ revealed an intense absorption maximum at 214 mμ ($\epsilon = 17{,}200$). In addition, another maximum of much less intensity was observed at 270 mμ ($\epsilon = 6{,}570$).

The presence of an acetoxyl group was confirmed by an acetoxyl group estimation. A quantitative hydrogenation using a Pd/C catalyst showed the presence of at least one double bond in enhydrin. But the other data (analytical, uv and nmr) indicate the presence of one more double bond in enhydrin and this does not probably suffer easy hydrogenation. The nmr spectrum of the product of hydrogenation differed from that of enhydrin in the following respects. The signals due to the exocyclic methylene protons had disappeared in the hydrogenated product and instead the doublet signal at δ 1·25 p.p.m., due to secondary methyl integrated for 6 protons as against 3 in enhydrin. There was no change in the number or position of the other methyl groups. Obviously, only the $\alpha:\beta$-unsaturated lactone ring had suffered hydrogenation.

Earlier,[1] we had inferred the presence of a tertiary hydroxyl group based on the observations that the i.r. spectrum had a weak broad absorption at 3650 cm.$^{-1}$ and the mass spectrum had a small peak at m/e 446, attributable to M–18. However, a micro estimation showed the absence of any active hydrogens in enhydrin. In order to check this point and also for the following reason, the mass spectrum of the compound was re-taken. The earlier record of the base peak at m/e 58 was an error and it was actually at m/e 78 which could have been due to benzene of crystallisation as the sample had been re-crystallised from that solvent. On repetition of the mass spectrum using a thoroughly dried sample, we found this peak to be indeed absent; now the base peak is the one at m/e 348. A prominent peak in the new spectrum was at m/e 404 (M–60) which was more intense than m/e 405 reported earlier. This peak could be explained as due to the loss of acetoxyl as acetic acid. Apart from these differences, the two spectra were alike; thus in both the molecular ion peak appeared at m/e 464. (We are not able to understand how the peak at m/e 446 arises.) Since the spectral and analytical data had previously indicated the presence of two γ-lactone groups, one saturated and the other $\alpha:\beta$-unsaturated, the base peak at m/e 348 might be due to a M-60-28-28 fragment. The peaks at m/e 91 and 105 may be significant as Geissman and Mukherjee[2] have noted these peaks in the mass spectra of all the sesquiterpenoid lactones examined by them.

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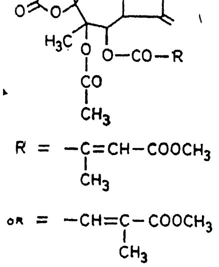
* Present address: Department of Chemistry, Central College, Bangalore-1.

Further, there were indications of the presence of a second acyloxy group besides the acetoxyl in enhydrin. The presence of such a fraction was indicated by the molecular formula assuming a sesquiterpene skeleton and by the position and high ϵ value of the uv absorption maximum at 214 mμ. This also suggested the probable presence of another chromophore such as α β-unsaturated ester besides the unsaturated γ-lactone. If one such was present it would probably be a C_5 or a C_6 unsaturated acyloxy group. However, the i.r. spectrum (no band below 1730 cm.$^{-1}$ in the carbonyl region) did not favour the presence of an $\alpha:\beta$-unsaturated ester group of the tigloyl or allied type found in some sesquiterpene lactones. The nmr data also ruled out such units. These results could only be explained if the acid part of the acyloxy group consisted of an $\alpha:\beta$-unsaturated dicarboxylic system, probably as its mono-methyl ester. In such a case, the $\alpha:\beta$-unsaturated ester carbonyl band will shift to a higher frequency due to opposing conjugation.[3] A probable tentative structure for enhydrin would then be (I).



$$R = -\underset{\displaystyle CH_3}{C}{=}CH-COOCH_3$$

$$\text{or} = -CH{=}\underset{\displaystyle CH_3}{C}-COOCH_3$$

(I)

In order to verify the above conjecture, an alkaline hydrolysis was attempted on enhydrin. Treatment with dilute methanolic alkali at room temperature gave a mixture of products, none of which was identical with the starting material. However, attempts to fractionate this mixture into acidic and neutral fractions were not successful and it has not been possible so far to isolate and characterise any of the products.

In the earlier communication,[1] we had reported our experience with regard to the variation in contents of *E. fluctuans* from batch to batch. A better yield of pure enhydrin is obtained from the leaves of the plant, whereas when the leaf-content of the whole plant is less, a complex mixture is obtained from which enhydrin is isolated only with difficulty. Since it is a marshy plant available near Calcutta, we have been able to get only the air-dried whole plant and a certain amount of variation in contents and yield from batch to batch could not be avoided.

From one of the batches we isolated a minor component which appeared along with enhydrin in the petroleum ether extract. However, this compound was insoluble even in hot benzene in which enhydrin is freely soluble and thus the two could be easily separated by crystallisation. As the quantity available was very small (less than 50 mg.) only a brief preliminary study has so far been possible. It has a melting point of 272–77° C. and the elemental analysis and molecular weight determination (mass spectrum, 320) agree with the molecular formula $C_{20}H_{32}O_3$. In t.l.c. it has a lower R_f than enhydrin and its uv spectrum in ethanol exhibits only end absorption above 210 mμ (ϵ at 210, 3840). The i.r. spectrum has frequencies at 3650 cm.$^{-1}$ and 1718 cm.$^{-1}$ The former may be attributed to the presence of a hydroxyl function. This is supported by the formation of an acetate with acetic anhydride and pyridine and also by the appearance of a prominent peak at m/e 302 (M-18). The absorption at 1718 cm.$^{-1}$ is very sharp and there is no indication of any unsaturation. This suggests that the carbonyl group in this compound may either be a lactone (J) or a carboxyl group. The mass spectrum of this compound has other prominent peaks at m/e 262, 147, 135, 121, 109, 105, 94, 91, 81, 79, 55 and 43. The base peak is at m/e 43.

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LETTERS TO THE EDITOR

KINETICS OF CHEMISORPTION OF HYDROGEN ON IRON-KIESELGUHR: APPLICATION OF THE EQUATION OF KODAMA *ET AL.*

KODAMA *et al.*[1] assumed the surface of a catalyst to be heterogeneous and a molecule of hydrogen to be adsorbed on such a surface after dissociating into atoms, in which case equations of the following type could be written for various sites:

$$\frac{dX}{dt} = k_a \mathrm{P}\,(\mathrm{A} - \mathrm{X})^2 - k_d \mathrm{X}^2 \qquad (1)$$

where 'X' is the amount of hydrogen adsorbed by sites of a particular activity. Neglecting the desorption velocity, equation (1) can be transformed into the form

$$\frac{t}{\mathrm{X}} = \frac{t}{\mathrm{A}} + \frac{1}{\mathrm{A}^2\mathrm{K}} \qquad (2)$$

where A and K are constants. The applicability of this equation to the kinetics of hydrogen chemisorption on a few catalysts were also reported by the same authors.[2] In spite of the suitability of equation (2) to the treatment of kinetic data on hydrogen chemisorption, it has somehow missed the attention of the workers in this field.[3] In the present paper, the equation of Kodama *et al.* has been successfully applied to the kinetics of hydrogen chemisorption on an iron catalyst.

The adsorbent was a reduced sample of Iron-Kieselguhr (5·47 gm.) prepared by the method of impregnation having a specific surface area of 27·62 m²/gm. The kinetics of adsorption of hydrogen were studied employing a conventional volumetric adsorption apparatus[4] at a constant pressure of 680 mm. and temperatures of 97, 150, 200, 250, 300 and 350° C. taking the usual precautions.

The kinetic data were employed for testing the applicability of equation (2). The plots of t/X *versus* 't' at various temperatures are shown in Figs. 1 and 2. It is seen from the figures, that the points lie on two intersecting straight lines at each temperature. The points plotted from the data at 150° C. show some scatter.

The constants A_1, K_1 and A_2, K_2 in equation (2) were calculated for both the linear portions of the plots and are shown in Table I. The value of the constants differ somewhat from those reported by Kodama *et al.*,[1] who have obtained for a similar system the values of A_1 and A_2 at temperatures of 100, 157, 207 and 255° C. as 1·83, 1·96; 1·78, 2·05; 1·80, 2·04 and 1·72, 1·93 respectively.

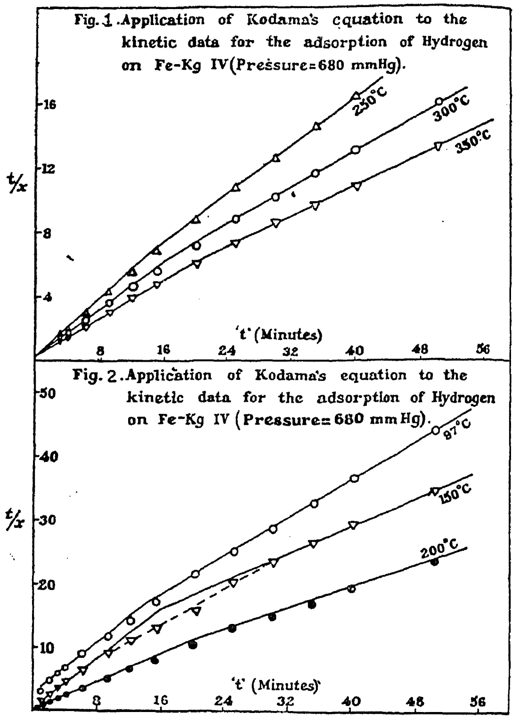
Fig. 1. Application of Kodama's equation to the kinetic data for the adsorption of Hydrogen on Fe-Kg IV (Pressure=680 mmHg).
Fig. 2. Application of Kodama's equation to the kinetic data for the adsorption of Hydrogen on Fe-Kg IV (Pressure=680 mmHg).

FIGS. 1–2

TABLE I

Temperature °C	A_1	K_1	A_2	K_2
97	2·00	0·893	1·23	0·105
150	2·06	0·3 2	1·85	0·0 0
200	1·87	0·722	2·30	0·097
250	2·14	1·37	2·72	0·095
300	2·70	0·595	3·46	0·060
350	3·25	0·474	4·24	0·040

The treatment of the same kinetic data through the Elovich equation[5] revealed all the general characteristics, as reviewed by Low.[3] To explain the applicability of both the equations to the same kinetic data, it was suggested[5] that the two equations have similar terms on expansion, as shown below:

Kodama's equation

$$\frac{t}{X} = \frac{t}{A} + \frac{1}{A^2K}$$

$$X = A^2Kt\,(1 + AKt)^{-1}$$

$$= A^2Kt - A^3K^2t^2 + \cdots$$

Elovich equation

$$X = \frac{1}{\alpha}\,ln\,(1 + a\alpha t)$$

$$= at - \frac{a^2\alpha t^2}{2} + \cdots$$

where a and α are constants.

Kodama's equation can be expected to have a wider applicability than the Elovich equation, because of the double exponential nature of the expression.

Dept. of Chemistry, C. S. SWAMY.
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PHYSICOCHEMICAL STUDIES ON A THIOPROPIONIC ACID-COBALT COMPLEX

RENEWED interest on cobalt complexes with various sulphur donors as well as interesting correlations observed between their colour and stereochemistry[1-8] have prompted us to study complex formation between cobalt and thiopropionic acid $HS.CH_2.CH_2.COOH$ (abbreviated hereafter as TPA), a hitherto little studied chelating agent.[1-3,9,10] On adding an aqueous solution of TPA to an aqueous cobalt (II) solution, and making the resulting solution alkaline (pH 9·0) (ammonia buffer: 0·4 M $NH_4OH + 0{\cdot}4$ M NH_4Cl), a green colouration appears, which on standing for some time in air turns dark-brown.[1-3] Previous workers[2] reported the probable oxidation of cobalt (II) to cobalt (III) during the course of potentiometric study. The present communication, however, records observations on polarographic, amperometric, magnetic, absorption spectral (ultraviolet, visible) studies on the system.

Amperometric studies reveal the 1 : 2 :: Cobalt : TPA stoichiometry. Polarographic studies were carried out separately in (*a*) absence of air and (*b*) presence of air.

(*a*) *Studies in Absence of Air.*—Increasing amounts of TPA were added to Co (II) solution ($2{\cdot}4 \times 10^{-4}$ M) of fixed strength ($0{\cdot}4 \times 10^{-4}$ M) at pH 9·0 (ammonia buffer). Two (polarographic) waves were observed: one anodic due to free TPA and another cathodic due to reduction of cobalt (II) to cobalt (Hg) amalgam, an irreversible wave; $E_{\frac{1}{2}} = -1{\cdot}2$ V (*vs.* S.C.E.).

(*b*) *Studies in Presence of Air.*—On carrying out these studies in presence of air, apart from one anodic wave due to free TPA, two cathodic waves were observed (first starting at $-0{\cdot}29$ V and the second one at $-0{\cdot}9$ V). The height of the second cathodic wave is double the height of the first one.

It is known that Co (II) in the presence of complexing agents is often oxidized to Co (III). The oxidation as well as the characteristics of cobalt-ammonia complexes have been studied by Laitinen *et al.*[11] Evidently the first cathodic wave is due to the reduction of Co (III) to Co (II) (one-electron reduction) while the second wave is due to the reduction of Co (II) to cobalt amalgam. The height of the first wave (a one-electron reduction) is practically half of the second wave (a two-electron reduction). Thus under the above conditions practically all the Co (II) appears to be converted into a brown-coloured Co (III) complex, also confirmed by the absorption spectra of this complex.

Magnetic measurements reveal the diamagnetic ($X_g = -12{\cdot}16 \times 10^{-6}$) behaviour of the complex solution (Metal : Ligand mixed in 1 : 2 ratio and pH brought to 9·0), as expected for octahedral spin-paired cobalt (III) ($3d^6$) complex.

Absorption spectra (recorded in solution; Metal : Ligand :: 1 : 2, pH 9·0, using Ligand + Buffer as reference) of the complex shows absorption bands at 18200 cm.$^{-1}$, 23550 cm.$^{-1}$ involving electronic transition ${}^1A_{1g} \rightarrow {}^1T_{1g}$, ${}^1A_{1g} \rightarrow {}^1T_{2g}$ respectively, a characteristic of spin-paired octahedral cobalt (III) complexes. The 10 Dq comes out to be 18200 cm.$^{-1}$ and the corresponding ligandfield stabilization energy 20·8 Kcals/mole.

The authors are thankful to Messrs. Evans Chemeties (N.Y.), U.S.A., for gift sample of

TPA, and to C.S.I.R., New Delhi, for financial assistance.

Chemical Laboratories, Mukund B. Mishra.*
Univ. of Allahabad, H. L. Nigam.
Allahabad-2, *February* 6, 1969.

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* Present address: Physical Research Wing, C.I.F.T. Buildings, P & D Division, F.C.I. Ltd., Sindri, Dhanabad.

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OCCURRENCE OF A NEW 3-DEHYDRORETINOL CONGENER

Although a true anhydro compound of 3-dehydroretinol is not known to occur in nature, Henbest *et al.*[1] obtained, by subjecting anhydroretinol to Wohl-Zeigler reaction, a compound whose absorption spectrum showed bands at 433, 408, 387 mμ indicating a 2-dehydroanhydroretinol structure of the compound. Barua and Nayar[2,3] found, during chromatography of liver oils of *Bagarius bagarius* fish, a fraction exhibiting in its absorption spectrum a number of peaks at 433, 408, 388, 368, 350, 310, 296, 284 mμ. These workers also prepared this compound by treating 3-dehydroretinol with the usual dehydrating agents used in the preparation of anhydroretinol and forwarded evidences to show that the compound was a hydrocarbon. Further work on the nature of this compound was carried out and herein we report the occurrence of a new congener of dehydroretinol.

Liver of *B. bagarius* fish was ground, extracted at room temperature with light petroleum (b.p. 40–60°), the solvent was removed by distillation under reduced pressure at 40°. The oil thus obtained was dissolved in light petroleum and chromatographed on a column of water-deactivated (5%, *v/w*) alumina and developed with the same solvent. The fast moving first fraction showed to be anhydroretinol, the second fraction exhibited absorption peaks at 433, 408, 388, 368, 350, 310, 296, 284 mμ, and the third fraction showed to be β-carotene. The substance from the second zone was also prepared by treatment of dehydroretinol with (*i*) a saturated solution of hydrogen chloride in light petroleum, or (*ii*) a saturated solution of *p*-toluene sulphonic acid in benzene, or (*iii*) a dry ethanolic solution of hydrogen chloride (N/5). This substance, exhibiting a complex spectrum, was rechromatographed on a column of alumina (active). Development with light petroleum resulted in the separation of three zones which were eluted with light petroleum. The spectral characteristics of the substances from the different zones are described below.

Zone I: $\lambda_{\text{max.}}$ 367, 350 (max), 335 mμ (light petroleum); $SbCl_3$ product $\lambda_{\text{max.}}$ 620, ~ 690 mμ.

Zone II: λ_{max} 390, 367 (max.), 350, ~ 335 mμ (light petroleum); $SbCl_3$ product $\lambda_{\text{max.}}$ 610, ~ 670 mμ.

Zone III.: $\lambda_{\text{max.}}$ 433, 408 (max.), 388 mμ with subsidiary peaks at 310, 296 mμ (light petroleum); $SbCl_3$ product $\lambda_{\text{max.}}$ 595 mμ.

The pattern of the absorption spectrum of the compound from the third zone is similar to that of anhydroretinol. On partition between light petroleum and 95% (*v/v*) methanol, it was found entirely in the epiphasic layer. All these, along with the observation that it occupied an intermediate position between anhydroretinol and β-carotene in the chromatogram, indicated the compound to be a hydrocarbon which was further supported by its infra-red spectrum. The visible spectrum is indicative of a 2-dehydroanhydroretinol structure of the compound. The extraction of the oil and the isolation of the compound were carried out under very mild conditions described above, and is unlikely that the compound is an artefact. However, the compound was highly sensitive and with time the spectrum was changing with appearance of peaks at 367, 350 mμ and disappearance of peaks at 433, 408 mμ. It soon decomposes making further study difficult.

Grateful thanks are due to Dr. N. N. Siddhanta for encouragement and providing laboratory facilities.

Department of Chemistry,
Gauhati University,
Gauhati-14,
Assam, *March* 14, 1969.

A. B. BARUA.
M. C. GHOSH.

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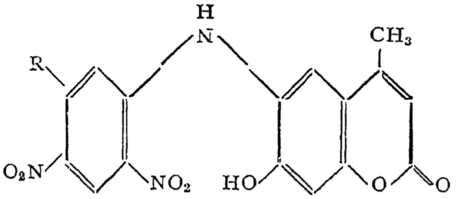
SOME N-ARYL SUBSTITUTED AMINO-HYDROXY-COUMARINS AND CHROMONES

IN earlier communications[1,2] the syntheses of some pyranophenoxazine derivatives were reported. It was observed however that if both the *ortho*-positions of the reactive halogen atom, in the halogeno nitro compound, were not occupied, corresponding uncyclised N-aryl substituted compounds were obtained, on condensation with *ortho*-amino hydroxy coumarins and chromones instead of the pyranophenoxazines, under the usual experimental conditions.[3,4]

In the present work these N-aryl substituted 6- and 8-amino-7-hydroxy-4-methylcoumarins and 8-amino-7-hydroxy-2-methylchromones are reported. They were obtained by refluxing equimolecular quantities of amino-hydroxy-coumarins and chromones with the reactive halogeno nitrobenzenes, in ethanolic solution, in presence of sodium acetate. A few compounds were prepared in this way by condensing 6- and 8-amino-7-hydroxy-4-methylcoumarins and 8-amino-7-hydroxy-2-methylchromone with 1-chloro-2, 4-dinitro-, 1, 3-dichloro-4, 6-dinitro and 1-chloro-4, 6-dinitro-3-metryl-benzenes (Tables I, II, III).

TABLE I

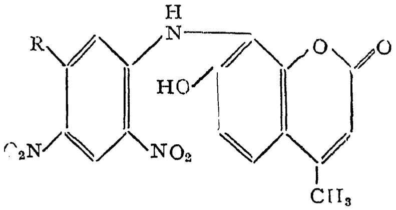
N-Aryl substituted 6-amino-7-hydroxy-4-methylcoumarins



No.	R	Formula	M.P.* °C.	Yield %	% Nitrogen Found	% Nitrogen Calculated
1	H	$C_{16}H_{11}N_3O_7$	285	56	11·60	11·76
2	Cl	$C_{16}H_{10}N_3O_7Cl$	>300	50	10·50	10·72
3	CH_3	$C_{17}H_{13}N_3O_7$	260	48	11·50	11·32

TABLE II

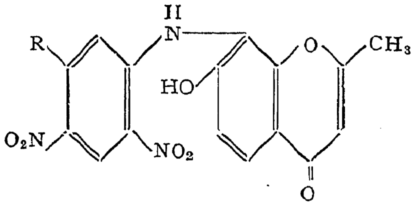
N-Aryl substituted 8-amino-7-hydroxy-4-methylcoumarins



No.	R	Formula	M P.* °C.	Yield %	% Nitrogen Found	% Nitrogen Calculated
1	H	$C_{16}H_{11}N_3O_7$	295^d	50	11·90	11·76
2	Cl	$C_{16}H_{10}N_3O_7Cl$	280	55	10·52	10·72
3	CH_2	$C_{17}H_{13}N_3O_7$	>300	44	11·54	11·32

TABLE III

N-Aryl substituted 8-amino-7-hydroxy-2-methylchromones



No.	R	Formula	M.P.* °C.	Yield %	% Nitrogen	
					Found	Calculated
1	H	$C_{16}H_{11}N_3O_7$	245	60	11·50	11·76
2	Cl	$C_{16}H_{10}N_3O_7Cl$	>300	65	10·58	10·72
3	CH₃	$C_{17}H_{13}N_3O_7$	>300	55	11·48	11·32

* Melting points are uncorrected.

These compounds may have interesting biological activities as some N-aryl-amino-hydroxy coumarins have been reported to possess antifungal and antibacterial properties.[5]

School of Chemistry, SATYENDRA KUMAR.*
Meerut College,
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* Present address: Research Division, Cleveland Clinic, Cleveland Ohio.

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DIRECT COLORIMETRIC METHOD FOR ESTIMATION OF CREATINE

IN the method usually adopted in clinical laboratories, creatine is heated with acid and dehydrated to give creatinine which is estimated colorimetrically by Jaffe' reaction. Specificity of this method is open to question[1,2] as Jaffe' reagent reacts with a great many reducing substances. Creatine is also estimated in microgram ranges by using the colour reaction with diacetyl and 1-naphthol.[3-7] But this method is not specific for creatine alone as arginine, guanidine, etc., develop the same colour. It is also not useful for urine samples.[4] The method presented here is a direct method for estimation of creatine in milligram amounts and is applicable to urine samples. Also, it requires only inexpensive and easily available chemicals.

As creatine contains in its molecule guanidino group, Sakaguchi's[8] test was tried with sodium hypobromite in place of sodium hypochlorite. At low concentrations of creatine, a yellow colour is produced with alkali, 1-naphthol and alkaline sodium hypobromite. At higher concentrations, yellow-red colour is obtained.

Reagents :

1. Creatine standard solution. 200 mg.% creatine in water.
   1 ml. = 2 mg. (creatine BDH, batch No. 440078 was used. E.M. Batch No. 5205 ; 7339786 also gave the same results).
2. Sodium hydroxide AR BDH. 10% aqueous solution.
3. 1-naphthol: 1% solution in pure ethanol.
4. Alkaline sodium hypobromite solution: prepared by dissolving 1 ml. of liquid bromine in 225 ml. of 1N sodium hydroxide. The solution has a pH of 11·5 and pale yellow in colour.

Concentrations of creatine solution differing by 0·5 mg. up to a maximum of 8 mg. were taken in different tubes with a blank. The volume in each case was made up to 4 ml. with distilled water. Subsequently 1 ml. of sodium hydroxide, 0·08 ml. of 1-naphthol and 3 ml. of alkaline sodium hypobromite were added in the order given and the contents mixed well. In tubes with 0·5 mg. to 7·5 mg. of creatine, yellow colour with increasing intensity is formed while in tube containing 8 mg., the colour is yellow-red. Blank is colourless. By using Hilger AIMIL Biochem absorptiometer, various wavelengths were tried and it was found that 430 mμ was the best for observing changes in colour intensity.

The reaction was conducted at about 30° C. and readings taken within 5 minutes of colour development.

To find the possible interference of creatinine, a solution of creatinine zinc chloride containing 2 mg./ml. was treated in the same way. Creatinine develops a transient pink colour which disappears in about 2 minutes. Thus creatinine does not interfere in this method.

The colour corresponding to 0·5 to 7 mg. of creatine obeys Beer's law (Fig. 1). Recovery experiments gave reproducible results with an error of less than 2% for pure samples.

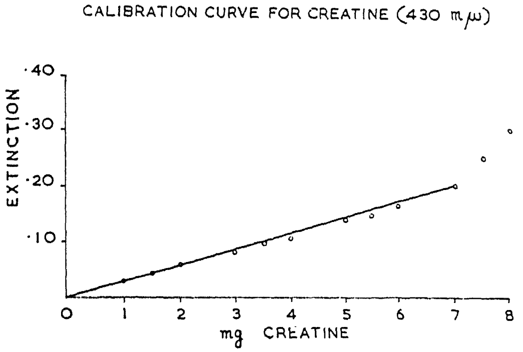

FIG. 1

In using this method for the estimation of creatine in urine samples, the following points should be borne in mind: (1). As creatine content in normal urine is very low, the urine must be concentrated. (2) As creatine is easily converted to creatinine *in vitro* in acid pH, heating should be avoided in acid pH. (3) Arginine which may be present in urine has to be removed as it is likely to interfere.

The following procedure was adopted. A known volume of urine was shaken with aluminium silicate in presence of oxalic acid after diluting the urine. After 30 minutes, it is filtered. Creatinine is adsorbed by aluminium silicate in acid medium and is thus removed. The filtrate which was clear and which did not answer Jaffe' reaction was made decidedly alkaline and evaporated to a small volume. Any arginine will be converted to citrulline, urea, etc.[9] After thus eliminating the interfering substances, the concentrated filtrate was made up to a known volume and used.

It was found that the creatine levels in a few samples of normal adult male urine as determined by the above method ranged from 78 mg./24 hour period to 124 mg. while for the same samples, Jaffe' method gave a range of 95 mg. to 146 mg.

The author's thanks are due to Dr. D. J. Reddy, Principal, and Dr. K. Subrahmanyam for their encouragement.

Dept. of Biochemistry, S. RAMAKRISHNAN.
Jawaharlal Institute of Post-graduate
Medical Education and Research,
Pondicherry (S. India),
February 11, 1969.

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ISOLATION OF PSEUDOLYCORINE FROM THE BULBS OF *AMARYLLIS EQUESTRIS* AIT.

Amaryllis equestris Ait. (Syn. *Hippeastrum equestre* Herb.) (Amaryllidaceæ) is native to Central America and the West Indies, but naturalized in many parts of India. Ganguly *et al.*[1] have recently reported the isolation of lycorine from the bulbs of *H. equestre.* We record here the isolation of pseudolycorine, besides lycorine and β-sitosterol, from a variety of *Amaryllis equestris* (double flower) available in N. India. Pseudolycorine was first isolated in 1932 from *Lycoris radiata*[2] and no further isolation was reported for a long time. However, methylpseudolycorine was isolated from *Narcissus pseudonarcissus.*[3] Recently pseudolycorine was reported to occur in two Amaryllidaceous plants, *Narcissus tazetta* var. *chinensis*[4] and *Lycoris squamigera.*[5]

Fresh bulbs of *A. equestris* were minced and extracted with alcohol. The extract was concentrated to a low bulk under reduced pressure to remove all alcohol and extracted successively with petroleum ether, chloroform and chloroform-alcohol (2 : 1). The solid material separated at the interphase during these extractions was removed by centrifuging. The original aqueous extract was further concentrated, half-saturated with sodium sulphate and extracted with chloroform-alcohol (2 : 1).

The petroleum ether extract gave an oily residue which when chromatographed over alumina gave a crystalline compound, m.p. 134–36°. It was identified as β-sitosterol by direct comparison with an authentic sample[6] and by preparing its acetate, m.p. and m.m.p. 124–26°.

The chloroform-alcohol (2 : 1) extracts obtained before and after half-saturation with sodium sulphate gave identical spots in t.l.c. Repeated crystallizations of the residues from acetone-alcohol gave shining prisms, m.p. 238–40°, $[\alpha]_D - 68 \cdot 2°$ (methanol) (yield 0·01%). The substance thus obtained answered the usual reactions for alkaloids. It was soluble in sodium hydroxide and gave a green colour with ferric chloride. It did not possess a methylenedioxy group (negative gallic acid test) and analysed for the formula $C_{16}H_{19}NO_4$ with one methoxyl. With diazomethane the compound formed a monomethyl ether, $C_{17}H_{21}NO_4$, needles from methanol, m.p. 228–32°. These properties closely resembled those of pseudolycorine and its methyl ether. The identity was established by direct comparison, m.m.p. and t.l.c., of the methyl ether with authentic methylpseudolycorine kindly supplied by Prof. W. C. Wildman. Further confirmation was obtained by comparison of the i.r. spectra of the alkaloid and its methyl ether with the standard spectra of pseudolycorine and methylpseudolycorine.

The solid material separated at the interphase was refluxed with chloroform-alcohol mixture. The solution on concentration deposited a crystalline compound, m.p. 265–68°, $[\alpha]_D - 85 \cdot 3°$ (ethanol) (yield 0·015%). This was found to be a non-phenolic alkaloid having a methylenedioxy group. It analysed for the formula $C_{16}H_{17}NO_4$ and formed a diacetate, m.p. 218–20°, $[\alpha]_D + 25 \cdot 4°$ (chf.). These properties suggested that the alkaloid could be lycorine. Mixed m.p. of the acetate with authentic lycorine diacetate[7] confirmed the identity.

We are grateful to Prof. W. C. Wildman, Department of Chemistry, Iowa State University, U.S.A., for supplying a reference sample of methylpseudolycorine and for running the i.r. spectra of our samples in his laboratory and comparing them with the standard spectra. Our thanks are due to Prof. V. Subba Rao for his interest in this work.

Dept. of Pharmacy, E. VENKATA RAO.
Andhra University, M. NAGESWARA RAO.
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MESOLITE FROM POONA

THIS note reports some new work on mesolite. It occurs commonly in the cavities of Deccan basalts in association with stilbite, heulandite, apophyllite, etc., and calcite. Such occurrences are generally grouped under natrolite[1] but it is desirable that the minerals like scolecite, mordenite, mesolite, etc., should be reported precisely. The sample under study has been collected from Poona (Erandawana quarry), which exposes beautiful prismatic crystals about 8 cm. in length and from 0·5 to 1·0 mm. in width.

Mesolite from Poona was originally described under the name Poonahlite by Brooke (1831).[2] He concluded that the crystals although bearing an apparent similarity to mesotype (natrolite) or needle-stone (scolecite), they differed from both the substances in measurement: Poonahlite being a rhombic prism of 92° 20′. Bowman (1909)[3] described specimens answering precisely to Brooke's[2] description as mesolite. Bowman's[3] analysis and optical studies agree with those of mesolite. However, the prism angle of mesolite is 91° 29′. He attributes the difference to confusion from internal reflections.

Scolecite often occurs in large crystals as those of mesolite under study, but chemical data affords easy identification (very poor in soda and very rich in lime). Optically the crystals are twinned, extinction about 10 degrees to elongation, birefringence fairly strong. Mordenite usually occurs in thin fibres, with a much lower refractive index but higher birefringence than mesolite. It shows straight extinction and is not easily attacked by acids. Much of the so-called mesolite from Bombay-Poona railway cuttings has been proved to be mordenite. Natrolite forms untwinned needles and prisms with medium birefringence, straight extinction and positive elongation. Natrolite however is unlikely in a lime-rich paragenesis as Poona. Stilbite is often radiated, platy and is very easily distinguished from other platy zeolites as it is almost always twinned, cleavages show sectoral pattern, with sectors extinguishing about 10° apart.

The crystals of mesolite are colourless or white, prismatic, acicular and radiating. They are elongated and twinned along *b*-axis, hardness 5, and specific gravity 2·2897. Figure 1 shows the crystals of mesolite under study.

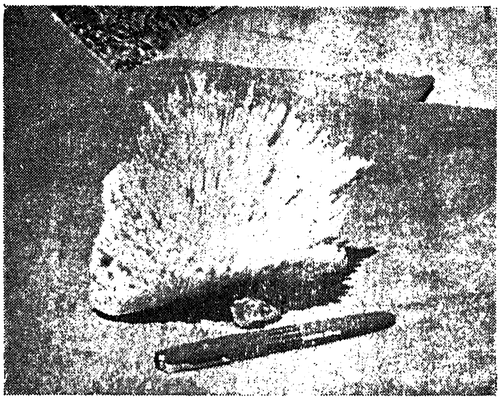

FIG. 1. Showing habit of mesolite crystal.

Colourless and clear crystals of mesolite were separated, crushed and analysed using standard gravimetric methods.[4] The water content was determined by loss on ignition in a platinum crucible. Na_2O and K_2O contents were determined by using Shand's techniques.[5] The results are shown in Table I. It will be seen that the results are in accordance with published data.[6]

TABLE I

SiO_2	46·05
Al_2O_3	28·93
CaO	8·76
K_2O	0·45
Na_2O	4·35
$H_2O\pm$	11·59
Total	100·13

The crystals are invariably twinned along *b*-axis, (sectors on basal sections) positive or negative elongation, birefringence very low (grey of I order). They show straight extinction but may appear to be inclined (2-5 degrees) if the crystal is not lying truly flat on the slide as optic axes emerge nearly normal to the prism faces. The interference figure is biaxial with a very large axial angle. The X-ray studies on this material by Dr. Hey show the mineral to be mesolite.

Thus from the chemical, physical, optical and X-ray studies it is concluded that the mineral under study is mesolite in very large crystals. It will be interesting to study the other similar (scolecite, mordenite, etc.) prismatic, acicular, fibrous zeolites and to report them as distinct members, and not under the natrolite group.

The author is highly indebted to Dr. M. H. Hey, British Museum (Natural History), London, for the X-ray identification of this mineral. He also expresses his sincere thanks to Prof. S. G. Ranade (Head of the Geology Department) for encouragement and providing facilities.

Department of Geology, M. R. BELSARE.
Walchand College of Engineering,
Sangli (Maharashtra),
January 23, 1969.

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ON THE RHYOLITES OF PAVAGAD HILL

THE rhyolites of Pavagad Hill were first noticed by Blanford[1] who described them as flows of volcanic mud of great tenacity. Fermor[2] recognized these as rhyolite and described the following types; rhyolite, silicified rhyolite breccia, ash and pitchstone. Fermor considered the rhyolites and the basalt as interbedded and described a specimen from near Atak Gate, as *in situ*. In their first report on the magma types in the Deccan Traps, Mathur and Dubey[3] considered the rhyolite as forming only top flow, but later Dubey[4] reported that the eruption of the rhyolite took place from several vents during the last phase of the Deccan Trap igneous activity. From his study of the radioactivity of the lavas, Dubey determined the age of the rhyolite flows as Miocene. As regards the source of the rhyolite lava, Dubey thought the turret at the top of the hill represents an intrusive plug because it is surrounded by agglomerates and ash.

In a recent paper on the lavas of the Pavagad Hill the present author[5] has described the occurrence of *ignimbrite* type of rhyolite at the top, and brought forward evidence in support of the *in situ* view of the occurrence of rhyolite. The recent construction of a motorable road from the Baroda-Shivrajpur road to the Machi Rest House at a height of over 600 feet from the base revealed only rhyolite in massive form beneath the surficial boulders all along the road showing thereby that the rhyolite on the eastern ridge is *in situ*. Behind Atak Gate is a low hillock of rhyolite with horizontal joints with huge blocks succeeding one another which leaves no doubt about the *in situ* origin of rhyolite here.

The mineralogical differences between the rhyolites on this side and those of the top, and also between these and the rhyolites of the northern hill were indicated in the author's paper.[5] Along with the mineralogical differences, there are also chemical differences.[6] The rhyolites of the top are dellenites or rhyodacites and they contain oligoclase as phenocrysts; but the rhyolites of the lower slopes and outlying hills are rhyolites in the true sense of the term. Anorthoclase is their main feldspar and they contain about 73% silica whereas the rhyodacites from the top contain about 67% silica.

The occurrence of welded flow on the top below the main temple and also in the outlying hillock to the south-east (559 ft.) shows that the eruptions took place as pyroclastic flows in between flows of viscous rhyolite since similar welded tuff flow has also been found at a lower level in the top turret. The pyroclastic flows are similar to the flow and deposition of *nuees ardentes*.

The welded tuff is composed mainly of fragmented, glass shards (Fig. 1). These shards have been compacted and welded into rhyolite. Collapsed pumice breccia is found near the north-western slope of the turret. Deformed collapsed pumice with phenocrysts of sanidine and sanidine crypto-perthite or anorthoclase are found. Glassy welded tuff is also associated with the topmost flow. The rock has been plastically deformed so that the pumice fragments are drawn into streaks and the dense tuffaceous glass with shards bends around the larger inclusions. Some of the welded tuffs are crypto-crystalline.

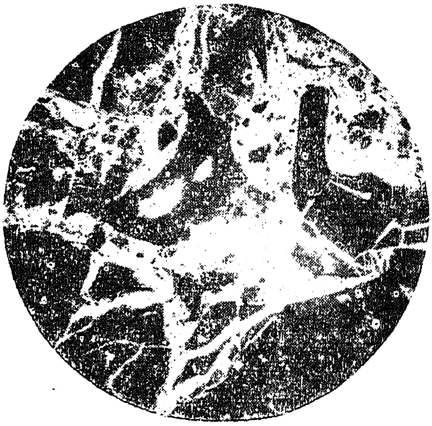

FIG. 1

According to Mansfield and Ross,[7] the constituents of the tuff in the Idaho plateau were blown into the air and later settled down and compacted. The heat was supplied by exothermic gas reactions. Kennedy,[8] on the other hand, proposed that the welded tuff in Yellowstone has been formed from collapsed froth flows rather than from pyroclastic flows.

The hapzard distribution of the tuffaceous flows in Pavagad Hill, and small bulk of these flows compared to the thick massive flows of viscous rhyolite suggest that these are pyroclastic tuffs which were thrown out from nearby vents by intermittent explosive volcanicity and were subsequently welded by their own heat aided by gas reactions. The mechanism seems to be similar to that advocated by Boyd[9] for the welded tuffs and flows of the Yellowstone Rhyolite plateau.

School of Studies in Geology, Vikram University,
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S. C. CHATTERJEE.

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ON THREE NEW GENERA OF SCIAENID FISHES (PISCES : SCIAENIDAE) FROM INDIA

ABSTRACT

Three new genera *Kathala, Macrospinosa* and *Panna* are proposed for the sciaenid fishes *Corvina axillaris* Cuvier and Valenciennes, *Bola cuja* Hamilton-Buchanan and *Otolithus microdon* Bleeker respectively. These species were formerly placed in various inappropriate genera. The present study is based on the structure of air-bladder, otoliths, lateral line pores on head and other morphological characters.

THE taxonomy of the sciænid fishes based on the external morphology remains very ambiguous. Chu, Lo and Wu (1963) arranged and classified the sciænid fishes of China into a well-defined system based on the structure of air-bladder, otoliths and rostral, marginal and mental pores on the snout and lower jaw. Though Chu, Lo and Wu (1963) classified the sciænid fishes of China correctly, they were not correct in classifying the sciænid fishes of India as pointed out by Trewavas (1965) in her review.

While studying the sciænid fishes of India, the necessity of creating three new genera was felt to accommodate three sciænid fishes, *Corvina axillaris* Cuvier, *Bola cuja* Hamilton-Buchanan and *Otolithus microdon* Bleeker that occur in India and at present placed in genera not appropriate.

Kathala gen. nov.

GENOTYPE : *Corvina axillaris* CUVIER, 1830

Generic Diagnosis.—Air-bladder simple, round anteriorly with a horn-like tubule on each side and tapering posteriorly. No lateral arborescent tubules (Fig. 1 *a*). Snout with 3 rostral pores, and five marginal pores, lower jaw with five mental pores—one median and an inner and an outer mental pore on each side Otolith (Sagitta) with a pointed anterior end and truncated posterior end, depression on anterior side very shallow and that of a posterior side deep, ventral side with three sharp tubercles. Teeth differentiated in upper and lower jaws. Gill rakers long, slender, serrated on both sides. Mouth terminal, oblique, upper jaw not overlapping the lower. Head 2·7 to 3·0 to S.L.D. IX-X, I, 26–29, A. 11, 7.

Kathala axillaris (Cuvier) Monotypic. *Distribution*: India, Ceylon, Java, New Guinea, Philippines, Australia.

Macropinos gen. nov.

GENOTYPE : *Bola cuja* HAMILTON-BUCHANAN, 1822

Generic Diagnosis.—Air-bladder simple, round in front with a pair of slender, bifurcated tubules on each side ventrally; posteriorly the air-bladder elongates into a narrow tube extending to the base of anal fin (Fig. 1 *b*). Otoliths (Sagitta) flat with truncated anterior and posterior ends, anterior dorsal surface with a shallow depression and posterior dorsal surface with a deep curved groove; ventral side with granules. Snout with 3 distinct rostral pores and five distinct marginal pores. Lower jaw with six mental pores, two median, and a slit-like inner and oval-shaped outer marginal pores on each side. Teeth, enlarged anteriorly in upper jaw, lower jaw with short teeth externally and a row of villiform teeth internally. Gill rakers flat, pointed terminally. Mouth sub-terminal, cleft of mouth nearly straight, upper jaw not over-hanging. Second anal spine stout, strong, equals to post-orbital length. Head 3·1 to 3·4 in S.L.D. X. I, 28, A. 11, 7.

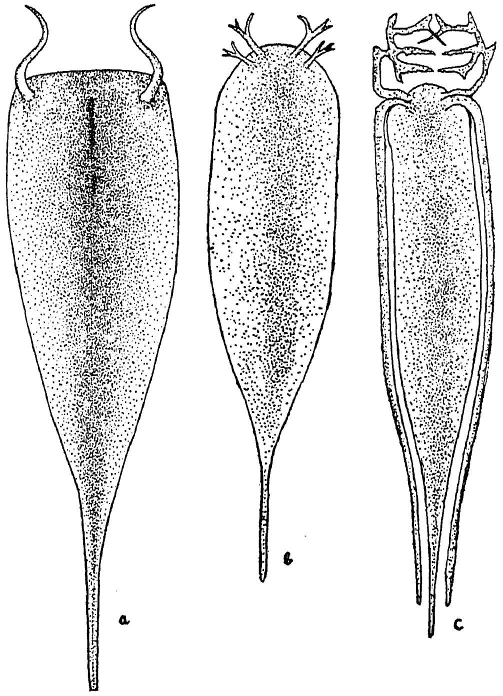

FIG. 1. Air-bladders of (*a*) *Kathala axillaris* Cuvier, gen. nov.; (*b*) *Macrospinosa cuja* Hamilton-Buchanan, gen. nov.; (*c*) *Panna microdon* Bleeker, gen. nov.

Macrospinosa cuja (Hamilton-Buchanan). Monotypic.

Distribution : Bengal coast (Bay of Bengal), Sitang river.

Panna gen. nov.

GENOTYPE : *Otolithus microdon* BLEEKER, 1849

Generic Diagnosis.—Air-bladder simple with a single branch on each side which divides into an anterior and posterior tubes. Anterior tube ramifies into the head and posterior tube extends up to posterior end of the bladder and ends blindly near the base of anal fin. Otoliths (Sagitta) narrow, elongate, with pointed anterior and posterior ends; anterior end with a shallow depression and the posterior end with a deep curved groove; ventrally with many granulated grooves. Snout with three indistinct rostral pores and five marginal pores. Lower jaw with six mental pores-2 median and an inner and an outer pores on each side. · Body elongated, snout pointed, mouth oblique, outer row of enlarged teeth in both jaws and inner row of villiform teeth. Upper jaw with two pairs of cananoid teeth anteriorly. Eyes small, second anal spine short. Head 3·1 to 3·4 in S.L.D. VII-IX, I, 33–34, A. 11, 7.

Panna microdon (Bleeker). Monotypic.

Distribution : India, Malaya, Southern China Sea.

I am thankful to Dr. E. G. Silas and Dr. P. S. B. R. James of this Institute, for their helpful suggestions in the preparation of this paper.

Central Marine Fisheries Research Institute,
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R. S. LAL MOHAN.

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EFFECT OF SALINITY ON THE FREE AMINO-ACID COMPOSITION OF THE BODY FLUID OF THE CRAB, *SESARMA PLICATUM* (LATREILLE)

DUCHÂTEU-BOSSON *et al.*[1] have pointed out that in euryhaline marine invertebrates, the degree of euryhalinity is accounted for either by an adjustment of the intracellular concentration, a regulation in which free amino-acids are involved, or by a combination of an osmoregulation of the blood and of an adjustment of the intracellular concentration to the level maintained in the blood as a result of osmoregulation. Mytilus[2] and *Arenicola marine*[1] are included in the first category while *Carcinus mœnas*[3,4] and *Eriocheir sinensis*[5] belong to the second category. Madan Mohan Rao[6] has suggested that amino-acids might be involved in the osmoregulation of the plasma of the rainbow trout, *Salmo gairdneri.*

The brackishwater crab, *Sesarma plicatum* (Latreille) is a good osmoregulator.[7] The crabs were acclimated to freshwater, 50% and 100% sea-water (33‰ salinity) for three weeks at room temperature during which period they were not fed. The body fluid was drawn with a hypodermic syringe through a leg joint. No anticoagulant was used. The body fluid was immediately subjected to qualitative analysis of free amino-acids using butanol-acetic acid-water, and ninhydrin for developing the chromatogram. The results are shown in Table I.

TABLE I

Free amino-acid composition of the body fluid of Sesarma plicatum (*Latreille*) *after acclimation to various salinities*

Free amino-acid	Fresh-water	50% sea-water	100% sea-water
Tryptophan ..	–	–	+
Phenylalanine ..	–	–	+
Leucine ..	–	–	+
Isoleucine ..	–	–	+
Tyrosine ..	–	+	+
Dihydroxyphenylalanine ..	–	+	+
Methionine ..	–	+	+
Valine ..	–	+	+
Alanine ..	+	+	+
Threonine ..	+	+	+
Serine ..	+	+	+
Glycine ..	+	+	+
Proline ..	+	+	+
Glutamic acid ..	+	+	+
Aspartic acid ..	+	+	+
Histidine ..	+	+	+
Lysine ..	+	+	+
Arginine ..	+	+	+
Cystine ..	+	+	+

+ = Present. – = Absent.

It could be seen that there is a qualitative difference in the amino-acid composition of the body fluids of crabs acclimated to the three different salinities. In 100% sea-water-acclimated crabs all free amino-acids for which we have looked into were present. In 50% sea-water-acclimated crabs four free amino-acids were totally absent (tryptophan, phenylalanine, leucine and isoleucine). In freshwater-acclimated crabs, in addition to the above four tyrosine, dihydroxyphenolalanine, methionine and valine were also absent.

It is interesting to note that identical results were obtained in the case of the plasma of *Tilapia mossambica* (Peters) acclimated to freshwater and 100% sea-water and also in the leaf extract of *Calotropis gigantea* growing on seashore and the one from the garden.

Thus it appears that a correlation exists between the habitat and the free amino-acid composition of the body fluids.

This investigation was supported by a research grant awarded to one of us (G. M. R.) by the University Grants Commission to whom grateful thanks are expressed.

Dept. of Zoology,
Sir Theagaraya College,
Madras-21, *January* 28, 1969.

G. Madan Mohan Rao.
M. Deecaraman.
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X-RAY IRRADIATION TO DISSECTED EMBRYOS OF RICE AND THEIR MUTATION SPECTRUM

Effect of irradiation on developing embryos has been studied so far mostly from intact growing plants.[1-4] To understand the effect of X-rays on excised embryos, *i.e.*, by eliminating the influence of maternal tissue and endosperm, dissected mature and immature embryos of rice were subjected to different doses of X-rays. Such a study would also reveal the relative radiosensitivity of different rice varieties representing distinct ecotypes and the mutation spectra they would produce following different doses of X-irradiations.

X-ray doses of 10 Kr to 35 Kr were applied to excised mature embryos, and in the case of 7-days-old immature embryos, the doses given were 1·5 to 16 Kr. Treated embryos were first grown *in vitro* in modified White's medium[5] and later in field conditions.

Germination was unaffected irrespective of doses and the seedling lethality could be noticed only from the seventh day onwards. Cent per cent germination of irradiated dissected embryos indicated that germination inhibitor wherever present was not located in the embryo proper. The lower percentage of germination, even at low levels of irradiation, as reported by earlier workers[1-4] in case of embryos in developing plants, should therefore be correlated either to the injury made to the enzyme system of the endosperm or indirectly to the production of toxic substances by irradiation. Nevertheless, as many established seedlings died after certain period of growth in the culture tube, it was realised that there is an injurious effect of X-rays, probably chromosomal, on excised embryos similar to that on whole seeds.

The LD_{50} and LD_{100} values (Table I) differed in different varieties indicating genotypic control. Some correlations have been found between radiosensitivity of varieties to their earliness or lateness or whether they were day-neutral or short-day types. Further, varieties with smaller embryos were more sensitive, irrespective of classes and duration to irradiation, than medium or larger-sized ones (Table I). Mikaelson and Halvorsen[6] also observed that smaller kernels were more susceptible to irradiation.

A significant but differential response to X-irradiation was noticed between varieties in respect of their shoot, root growth, number of leaves and number of roots in the seedlings. The effect was more pronounced on root system than on shoot. In adult plants also, the effect was equally pronounced in respect of plant height, number of reproduction tillers, panicle length, seed fertility and other morphological and floral abnormalities.

Mericle and Mericle[7] obtained highest mutation rate as well as larger 'isomutant-carrying sectors' in R_2 generation following proembryo irradiation. Here in our experiments with excised embryos, besides chlorophyll mutations other mutations (Table II) were also scored. Probability of getting useful mutations involving polygenic system appeared to be more in case of dissected embryos than in whole seeds, irrespective of varieties, because comparatively lower doses could be effectively employed for induction of mutation. Moreover, the chances of survival of both dominant and heterozygous recessive mutations in X_1 generation would be more when grown *in vitro* (Table II). There is thus fresh scope for obtaining wider

TABLE I

Differential response of mature and immature embryos of rice to X-irradiation

Material	Class	Duration in days	Embryo size	LD_{50} of seedlings (dose in Kr)	LD_{100} of seedlings (dose in Kr)
Satika ..	Day neutral	80	Small	15·6 ± 0·86	22 ± 1·68
Ashkhata ..	,,	120	Medium	22·5 ± *	35 ± *
Ashkhata (immature embryo) ..	,,	135	,,	5·5 ± 0·82	14 ± 1·42
Badkalamkati-65 ..	Short-day	125	Small	14·6 ± 1·00	20 ± 2·88
Kumargore ..	,,	145	,,	16·6 ± 1·66	25 ± *
Kerangserang ..	,,	155	Big	25·6 ± 0·82	35 ± *

* Since there was no deviation of the samples from their respective means, S.E. (±) was not calculated.

TABLE II

Mutation frequencies in different varieties of rice following X-ray irradiation of excised embryos

Material (mature embryo only)	Dose* (Kr)	Mutation frequency (Recessive) in percentage† in X_2 and confirmed in X_3 generations: Chlorophyll: Segregating families	Chlorophyll: Mutation cases	Other than chlorophyll: Segregating families	Other than chlorophyll: Mutation cases	Per cent. of dominant mutations in X_1 and confirmed as true breeding in later generations
Satika (25 embryos per treatment)	10	12	20	24	36	..
	15	12	30	8	28	..
Ashkhata (50 embryos per treatment)	15	4	30	..	..	..
	20	8	76	2	2	..
	25	12	124	4	24	2
	30	..	..	..	..	2
Kerangserang (25 embryos per treatment)	10	..	..	..	..	4

* 10, 15, 20, 25 and 30 Kr were employed in each case. Only those doses are shown in the table where mutations have been scored.

† Mutation frequency calculated on the basis of number of segregating families per 100 X_1 embryos and also from the number of mutation cases per X_1 embryos.

mutation spectrum in cereals by irradiating dissected embryos using lower doses of X-irradiation.

This work has been sponsored by the Indian Council of Agricultural Research, New Delhi.

Dept. of Botany, Burdwan University, Burdwan (W. Bengal), *October* 25, 1968.

P. N. BHADURI.
A. SHOME.

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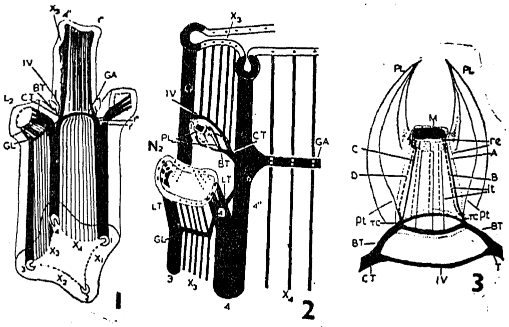
BUD TRACE CONNECTIONS IN *TECTONA GRANDIS* L.

Tectona grandis is an important timber tree. Recently we[1] investigated the vascular connections of axillary buds in some members of the Varbenaceæ and the Labiatæ. The axillary bud traces of *Tectona*, a member of the family Verbenaceæ, show certain peculiar features.

In the primary vascular system of the internode, a large vascular strand is evident below each ridge of the quadrangular stem (strands 1–4 in Fig. 1). In between these strands there are smaller vascular strands, collectively named X_1, X_2, X_3 and X_4 for each side. The node in Fig. 2 is labelled as N_2. The first node N_1 and its leaves are not shown in the figure but are considered to be immediately above N_2. The branch 4′ continues as a leaf trace LT (Figs. 1, 2). It enters the lateral side of the petiole and branches further. The vascular strand 4″ gives rise to a branch, GA, which turns horizontally towards the axis and keeps a peripheral course (Figs. 1, 2). The vascular strand, GA, unites with the one which is similarly formed from the opposite vascular strand 1″ and forms a girdle in the axis (Fig. 1). The vascular strand 3 also behaves like 4 and the behaviour of 1 and 2 shows similarity to 3 and 4. The branches of 3 and 4 and the intermediate strands X_3 constitute a leaf trace. The vascular strands entering the leaf laterally branch further. The vascular strands of the leaf trace get interconnected by a girdle, GL, on all the four sides at the proximal end of the petiole (Figs. 1, 2). The girdles, GL and GA, appear more or less continuous.



FIGS. 1-3. Fig. 1. Vasculature seen in young cleared node. Fig. 2. Diagrammatic representation of node shown in Fig. 1. Fig 3. Diagrammatic representation of the development of primary vascular system of a bud in vertically oriented view. (A, B, C and D—Primary vascular strands of bud; BT—Bud trace, CT—Common strand; GA—Girdle in the axis region of the node; GL—Girdle at the base of the petiole; L_2—Leaf; LT—Leaf trace; *lt*—Trace of the bud leaf; M—Bud apex; N_2—Second node; Pl.—Prophyll; *pt*—Prophyll trace; TC—Ring like vascular tissue; X_1, X_2, X_3 and X_4—Smaller vascular strands; 1-4 1″ and 4″—Prominent vascular strands; 1′ and 4′—Leaf trace vascular strands.)

The intermediate strands X_4 and X_2 traverse up to the node N_2. Their position is below the girdle while traversing the internode above. They do not fuse with the girdle in the young stem but in the mature condition connections are observed. The intermediate strands X_4 behave in the node N_1, as X_3 strands, in node N_2. The strands 1″ and 4″ also travel up to N_2. The vascular strands 1″, X_4 and 4″ can be compared to the strands 3, X_3 and 4.

At the level of the bud, the vascular strand 4″ gives rise to a branch CT which takes a short horizontal course. CT again forks into a bud trace BT and a common vascular strand, IV, for the internode above. The bud trace BT takes a horizontal but outward diversion towards the base of the bud. The common vascular strand for the internode IV, meanwhile takes a horizontal but inward diversion. From this the intermediate strands, X_3, arise in the internode above. Each bud trace BT divides into two. The plane of bifurcation of bud trace BT is at right angles to the plane of bifurcation of the common strand CT. The two branches of each bud trace from opposite side meet and form an oval ring at the base of the bud (Figs. 2, 3). The prophyll traces and traces for bud leaves are associated with this vascular tissue (Fig. 3).

Schematic representation of the bud with its primary vascular system is illustrated in Fig. 3. The bud trace BT and the common vascular strand for the internode above, IV, are branches of the strand, CT. Each bud trace bifurcates at the base of the bud. The plane of its bifurcation is at right angles to that of the strand, CT. The branches from the opposite bud traces fuse and form an oval provascular ring at the base of the bud, *tc*. The prophyll trace, *pt*; the leaf traces, *lt*; the vascular strands, A-D and the intermediate smaller strands arise from this vascular ring. The primary vascular system of the young bud is represented below the summit of the bud apex.

The axillary bud traces of *Tectona* show certain peculiar features. The origin of the common vascular strand giving rise to the bud traces and the vascular strands for internode above, resembles normal condition of bud trace connection of Ezelarab and Dormer.[2] But the important difference is that in the normal condition the bud trace arises from the vascular strand bordering the leaf gap*. Moreover, further development of bud traces and their relation with the primary vascular system of the bud in *Tectona* also call for a distinct catagorization of its bud trace connection. The node of *Tectona* shows unilacunar multitrace condition. The present observation also shows that the concept of branch gap requires reconsideration.

Dept. of Botany, J. J. SHAH.
Sardar Patel Univ., K. UNNIKRISHNAN.
Vallabh Vidyanagar,
Gujarat, *February* 18, 1969.

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* In *Tectona* the bud trace arises from a branch of a vascular strand flanking the axillant leaf gap.

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REVIEWS AND NOTICES OF BOOKS

Principles of Modern Heterocyclic Chemistry. By Leo A. Paquette. (W. A. Benjamin, Inc., New York and Amsterdam), 1968. Pp. xiv + 401. Price $ 11.95.

This new intermediate text for students of organic chemistry is a unified commentary on the significant synthetic and mechanistic aspects of fundamental heterocyclic chemistry. Each chapter is organized on the basis of reaction types and mechanistic pathways, and various ring systems under consideration are integrated completely within this framework. Abundant illustrations and literature references serve to further clarify the particular points under discussion, and exercises follow each chapter.

The articles contained in this book are: Three-Membered Rings with One Hetero Atom; Three-Membered Rings with Two Hetero Atoms; The Four-Membered Heterocycles; Furan, Pyrrole, and Thiophene; Condensed Five-Membered Heterocycles; The Azoles; The Pyridine Group; Quinoline and Isoquinoline; The Diazines and *s*-Triazine; Further Principles of Heterocyclic Synthesis; and Some Heterocycles of Biological Interest. C. V. R.

Microwave Spectral Tables (Vol. IV)—*Polyatomic Molecules without Internal Rotation.* By Marian S. Cord, Jean D. Petersen, Matthew S. Lojko, and Rudolph H. Hass. (National Bureau of Standards, Office of Technical Information and Publications, Washington, D.C. 20234), 1968. Pp. xii + 420. Price $ 5.50.

This volume concludes the compilation of data under the title of *Microwave Spectral Tables*—NBS Monograph 70, begun in 1953 by Dr. Paul F. Wacker. Volume V, published prior to this volume, contains a numerical listing of spectral lines given in Volumes I, III, and IV. Volume I, Diatomic Molecules, and Volume II, Line Strengths of Asymmetric Rotors, were completed under the supervision of Dr. Wacker and published in December, 1964.

In May, 1964, general supervision of the project was assumed by Dr. Yardley Beers. Subsequently, Mrs. Marian Cord was appointed project leader for the completion of Volume III, Polyatomic Molecules with Internal Rotation, Volume IV, Polyatomic Molecules without Internal Rotation, and Volume V, Spectral Line Listing.

The present volume under review contains the following articles: 1. Introduction; 2. Explanation of Tables; 3. List of Symbols, Abbreviations, and Conversion Factors: 3.1. Symbols and Abbreviations; 3.2. Conversion Factors; 4. Molecular Constants and Spectral Line Tabulation; 5. Index According to Empirical Formula; 6. Index According to Chemical Name; and 7. Bibliography. C. V. R.

Annual Review of Nuclear Science (Vol. 18). Edited by Emilio Segre. (Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. v + 553. Price $ 9.00.

Volume 18 of this well-known series contains the following articles: Shell-Model Theory of the Nucleus; High-Isospin Nuclei and Multiplets in the Light Elements; Elements Beyond 100, Present Status and Future Prospects; Review of Nuclear Weapons Effects; Nuclear Propulsion for Space Vehicles; Current Algebra; The Measurement of Short Nuclear Lifetimes; Magnetic Dipole Moments of Excited Nuclear States; Compound Nuclear Reactions Induced by Heavy Ions; The Radioactivity of the Atmosphere and Hydrosphere; Accelerators for High Intensities and High Energies; Materials for Water-Cooled Reactors; Effects of Radiation on Man; and Some Related Articles Appearing in Other *Annual Reviews*.

C. V. R.

Plant Nematology (*In Africa South of the Sahara*). By P. R. Thomas and C. E. Taylor. (Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Bucks, England), 1969. Pp. 83. Price 60 *sh.*

This publication, which is also the Technical Communication No. 39 of the Commonwealth Bureau of Helminthology, provides summaries of the literature on plant, soil and aquatic nematodes from Africa south of the Sahara, including Madagascar, Mauritius and Reunion. While most of the annotations relate to work undertaken and published in Africa they also include papers on African plant nematology published elsewhere, such as taxonomic studies and reports of visiting nematologists. There are 567 entries and the coverage is up to the end of 1965. The publication is no doubt an essential and useful reference literature to all helminthologists. A. S. G.

Mass Spectrometry. Edited by R. Brymner and J. R. Penney. (Butterworth and Co., Publishers Ltd., 88, Kingsway, London, W.C. 2), 1968. Pp. 275. Price 80 *sh.*

This volume contains the papers given at a symposium on Mass Spectrometry held at the Enfield College of Technology on 5th and 6th July 1967. Of the 21 papers, nine are from the manufacturing industries, five deal with the cracking or decomposition of ions, three papers are concerned with surface or catalytic interests, and one paper on flavone research shows an interesting application of the combination technique of gas chromatography and mass spectrometry for this type of research.

The publication of the symposium papers makes available in one volume information on design, use and applications of mass spectrometry which are essential to all workers in this field. A. S. G.

ANNOUNCEMENTS

Award of Research Degrees

Osmania University has awarded the Ph.D. degree to the following in subject mentioned against each: Shri Vissamsetti Hari Babu (Physics), Kumari Devika Rani Chattopadhyaya (Zoology), Shri G. Seenayya (Botany), Shantha Kumari (Zoology), D. Desaiah (Zoology), Shri Mohd. Mustafa Ali Khan (Zoology).

Utkal University has awarded the Ph.D. degree in Botany to Shri R. N. Mohanty.

M.S. University of Baroda has awarded the Ph.D. degree in Statistics to Shri Pravin Hiralal Dave; Ph.D. degree in Zoology to Shri Yashavantrai Maganlal Naik.

Symposium on 'Radiations and Radiomimetic Substances in Mutation Breeding'

The symposium on "Radiations and Radiomimetic Substances in Mutation Breeding" organised by the Food and Agriculture Committee of the Department of Atomic Energy will be held at Bhabha Atomic Research Centre, Trombay, Bombay-85, during October, 1969. The last date for sending the abstracts for the contributed papers is July 31, 1969. The abstracts should be sent to Shri N. S. Rao, Biology Division, Bhabha Atomic Research Centre, Trombay, Bombay-85.

Symposium on Crop Palynology

It is proposed to hold the first symposium on Crop Palynology at the St. Joseph's College, Tiruchirapalli, Tamilnad, in September, 1969. Intending participants are requested to contact Prof. K. M. Mathew, Symposium Secretary for Crop Palynology, Department of Botany, St. Joseph's College, Tiruchirapalli, Tamilnad.

Further information can also be had from Dr. P. K. K. Nair, General Secretary-Treasurer, Palynological Society of India, National Botanic Gardens, Lucknow, U.P.

Institution of Chemists (India) Associateship Examination, 1970

The Twentieth Associateship Examination of the Institution of Chemists (India) will be held in November, 1970. The last date for Registration is 30th November, 1969.

Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

Lady Tata Memorial Trust—Scholarships and Grants for the Year 1969-70

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of the Lady Meherbai Dorabji Tata, 18th June 1969, the awards of scholarships and grants for the year 1969–70.

International Awards of varying amounts (totalling £ 6,283) for research in diseases of the blood with special reference to Leukæmias are made to:

1. Mrs. E. Davidson (Great Britain); 2. Dr. O. Mach (Czechoslovakia); 3. Dr. P. Stryckmans (Belgium); 4. Dr. G. B. Rossi (Italy) (Beginning from 1st July 1970); 5. Dr. Jean-Francois Dore (France); 6. Dr. Yves Najean (France).

Indian Scholarships of Rs. 300 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to:

1. Miss M. Banerjee; 2. Dr. (Miss) R. Keshwani; 3. Mr. D. S. Khaire; 4. Dr. (Miss) N. Parvati; 5. Mr. M. A. Siddiqi.

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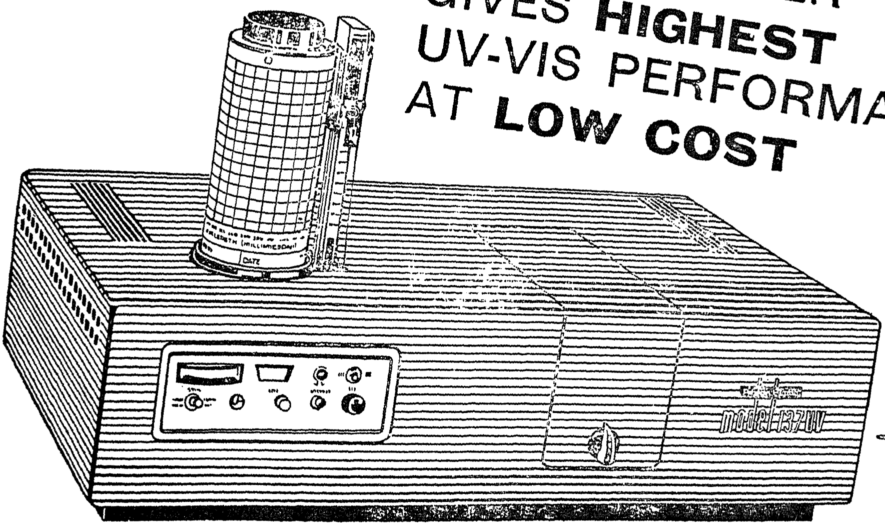

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THE EVALUATION OF SOME PIEZO-ROTATORY COEFFICIENTS OF α-QUARTZ

G. S. RANGANATH AND S. RAMASESHAN

Materials Science Division, National Aeronautical Laboratory, Bangalore-17, India

RECENTLY we have investigated the effect of pressure on the optical rotatory power of crystals.[1] The optical activity in crystals may be described by a symmetric second rank axial tensor (g) which may be represented by the tensor surface

$$g_{11} x^2 + g_{22} y^2 + g_{33} z^2 = 1$$

when referred to its principal axes.[2] There are no *a priori* restrictions laid on the signs of g_{11}, g_{22} and g_{33}.

When the crystal is stressed the surface represented by the tensor (g) deforms. If one assumes that, in the first order theory, the changes in the components of (g) are linear functions of stress X_{kl} or strain x_{kl} then

$$\Delta g_{ij} = -R_{ijkl} X_{kl}$$
$$\Delta g_{ij} = S_{ijkl} x_{kl}$$

where

$$\Delta g_{ij} = g_{ij} - g^{\circ}_{ij}$$

g°_{ij} and g_{ij} are the values of the ij^{th} component of (g) before and after stress. Since (Δg) is an axial tensor of 2nd rank and both X_{kl} and x_{kl} are polar tensors of 2nd rank, the piezo-rotatory tensors R_{ijkl} and S_{ijkl} should be 4th rank axial tensors. This is perhaps the first time such tensors are used to describe a physical property. The number of non-vanishing coefficients of this tensor for different point groups has been worked out by us using group theoretical methods[3,4] and the forms of the matrices for the point groups have also been determined.[1] Only non-centrosymmetric point groups have non-vanishing coefficients for the piezo-rotatory tensor. These crystals fall under three distinct classes.

Class A.—In the 11 enantiomorphic point groups which show optical activity the piezo-rotation tensor (R) or (S) and the piezo-refractive tensor (q) or (p) have the same form in the matrix representation. These groups with their number of non-vanishing coefficients (shown in parenthesis) are

1(36), 2(20), 222(12), 4(10), 422(7), 3(12), 32(8), 6(8), 622(6), 432(8) and 23(4)

Class B.—The 4 non-enantiomorphic optically active point groups for which piezo-rotatory and piezo-refractive matrices have different forms are

m(16), $mm2$(8), $\bar{4}$(10), $\bar{4}2m$(5).

Class C.—The 6 non-enantiomorphic optically inactive point groups show an interesting result in that the piezo-rotatory coefficients do not vanish, *i.e.*, stress actually induces optical activity in them. These groups with their respective number of non-vanishing coefficients are

$4mm$(3), $3m$(4), $6mm$(2), $\bar{6}$(4), $\bar{6}m2$(2), and $\bar{4}3m$(1).

α-quartz (point group 32) belongs to the class A, and has 8 independent coefficients. Its piezo-rotatory matrix is

$$\begin{array}{cccccc}
R_{11} & R_{12} & R_{14} & R_{14} & 0 & 0 \\
R_{12} & R_{11} & R_{13} & -R_{14} & 0 & 0 \\
R_{31} & R_{31} & R_{33} & 0 & 0 & 0 \\
R_{41} & -R_{41} & 0 & R_{44} & 0 & 0 \\
0 & 0 & 0 & 0 & R_{44} & 2R_{41} \\
0 & 0 & 0 & 0 & R_{14} & (R_{11}-R_{12})
\end{array}$$

One of the major impediments in the way of recovering all the piezo-rotatory coefficients is that it is rather difficult to measure the optical rotatory power in directions other than that of the optic axis. In the case of α-quartz the magnitude of only some of the coefficients, *viz.*, R_{31} and R_{33} may be readily determined. The changes in rotatory power along the optic axis for an uniaxial stress X_0 along the axis and for an hydrostatic stress X_h are given by

$$\Delta \rho_0 = -R_{33} X_0$$
$$\Delta \rho_h = -(2R_{31} + R_{33}) X_h$$

and should therefore differ for the same stress, *i.e.*, $X_0 = X_h$.

Recently, Vedam and his collaborators[5,6] have measured the optical rotation of α-quartz along the optic axis for hydrostatic and uniaxial stress. It was gratifying to note that the changes in rotation per unit stress were significantly different for these two types of stresses, as the theory predicts. The results of their experiment are shown in Table I.

TABLE I

	Pressure in K bar	Percentage strain parallel to optic axis	Percentage strain perpendicular to optic axis	$\Delta\rho^{\circ}$ mm.
1. Hydrostatic pressure	1·368	−0·1	−0·127	−0·232
2. Uniaxial stress along optic axis	1·025	−0·1	+0·013	−0·170

Now $\Delta g_{ij} = S_{ijkl}\, x_{kl}$ or $\Delta g_i = S_{ij}\, x_j$ in the one index form.

Hence

$$\begin{aligned} -0{\cdot}232 &= 2S_{31}(-0{\cdot}127 \times 10^{-2}) \\ &\quad + S_{33}(-0{\cdot}1 \times 10^{-2}) \\ -0{\cdot}170 &= 2S_{31}(+0{\cdot}013 \times 10^{-2}) \\ &\quad + S_{33}(-0{\cdot}1 \times 10^{-2}) \end{aligned}$$

giving

$$S_{33} = +1{\cdot}75 \times 10^2 \text{ degrees/mm./unit strain}$$
$$S_{31} = +0{\cdot}2214 \times 10^2 \text{ degrees/mm./unit strain}$$

elastic compliances of α-quartz in units of 10^{-12} cm.^{2}/dyne are[7]

$$s_{11} = 1{\cdot}277,\ s_{12} = -0{\cdot}179,\ s_{31} = -0{\cdot}122,$$
$$s_{33} = 0{\cdot}96,\ s_{14} = -0{\cdot}431,\ s_{44} = 2{\cdot}004.$$

Also since

$$R_{ij} = S_{ik}\, s_{kj}$$
$$\therefore R_{33} = 2S_{31}\, s_{31} + S_{33}\, s_{33}$$
$$R_{31} = S_{31}(s_{11} + s_{12}) + S_{33}\, s_{31}$$

substituting the values one gets

$$R_{33} = +0{\cdot}16298 \text{ degree/mm./k bar}$$
$$R_{31} = +0{\cdot}002959 \text{ degree/mm./k bar}$$

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THERMAL EXPANSION OF IRIDIUM DIOXIDE

K. V. KRISHNA RAO AND LEELA IYENGAR

Physics Department, Osmania University, Hyderabad-7, India

IRIDIUM DIOXIDE, which has a tetragonal rutile type structure, has been found to exhibit high electrical conductivity typical of metal-like conductors from the study of the electrical transport properties by Rogers *et al.*[1] and Ryden *et al.*[2] The lattice parameters of IrO_2 at room temperature have been reported recently.[1,3] A search of the literature shows that no studies on the thermal expansion of iridium dioxide seem to have been made so far. Hence it interested the authors to include this compound in a general programme of 'Studies on rutile type compounds by the X-ray method'. The present paper gives an account of the precision determination of the lattice parameters at different temperatures and the evaluation of the coefficients of thermal expansion at various temperatures.

The sample used in the present study was kindly supplied by Dr. W. D. Ryden of the University of California. The powder sample for the study was prepared by filling it in a thin-walled quartz capillary. Using a Unicam 19 cm. high temperature powder camera and CuK radiation from a Raymax-60 X-ray unit, powder photographs were taken at different temperatures. The present study was made for the temperature range 28° C. to 702° C. Reflections from the 213, 402, 510, 332, 501, 303, 422, 521, 323, 440 and 004 planes recorded between 55° to 78° Bragg angles were used in evaluating the lattice parameters at different temperatures. The experimental set-up and the computational procedure have been described in an earlier paper.[4]

The lattice parameters of IrO_2 at room temperature obtained in the present study are listed in Table I along with the other values available in the literature. The values from the present study agree well with the two recent determinations.

TABLE I

Lattice parameters of IrO_2 at room temperature

Source		a (Å)	c (Å)
Goldschmidt[5]	..	4·49	3·14
Swanson *et al.*[3]	..	4·4983	3·1544
Rogers *et al.*[1]	..	4·4920 ± 0·0002	3·1546 ± 0·0002
Present study	..	4·4985 ± 0·0001	3·1548 ± 0·0001

The lattice parameters obtained at different temperatures are given in Table II and shown graphically in Fig. 1. It can be seen that both

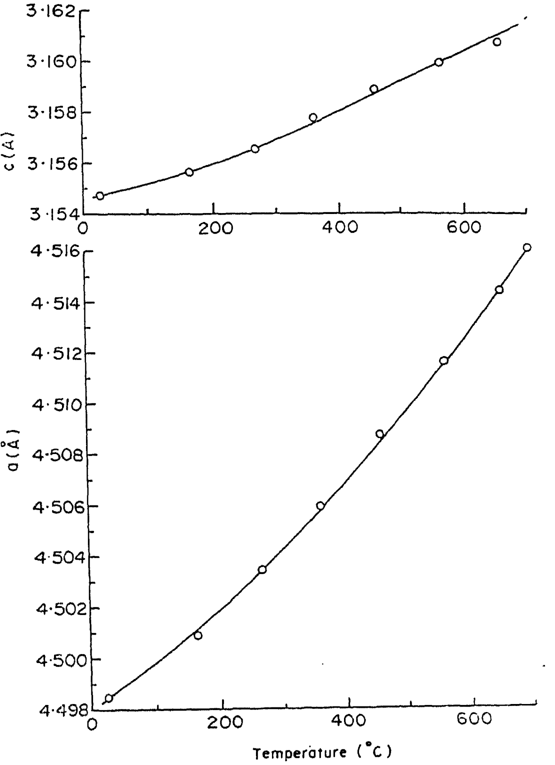

FIG. 1. Variation of the lattice parameters of IrO_2 with temperature.

the parameters increase with increasing temperature. The temperature dependence of the coefficients of thermal expansion, $\alpha_{\parallel}$ and $\alpha_{\perp}$ are represented by the following equations:

$$\alpha_{\parallel} = 1\cdot266 \times 10^{-6} + 8\cdot823 \times 10^{-9}\ t\ - 6\cdot870 \times 10^{-12}\ t^2.$$

$$\alpha_{\perp} = 3\cdot532 \times 10^{-6} + 7\cdot963 \times 10^{-9}\ t\ - 3\cdot825 \times 10^{-12}\ t^2.$$

TABLE II

Lattice parameters of IrO_2 at different temperatures

Temperature ° C.	a (Å)	c (Å)
28	4·4985	3·1548
165	4·5009	3·1557
267	4·5035	3·1566
361	4·5059	3·1578
461	4·5087	3·1589
563	4·5116	3·1600
655	4·5144	3·1609
702	4·5161	3·1619

$\alpha_{\parallel}$ and $\alpha_{\perp}$ obtained at different temperatures are listed in Table III.

TABLE III

Coefficients of thermal expansion of IrO_2 at different temperatures

Temp. ° C.	$\alpha_{\parallel} \times 10^6$		$\alpha_{\perp} \times 10^6$	
	Obs.	Calc.	Obs.	Calc.
50	1·66	1·69	3·84	3·92
90	1·90	2·00	4·17	4·22
130	2·22	2·30	4·45	4·50
170	2·69	2·57	4·78	4·78
210	2·85	2·82	5·17	5·04
250	3·09	3·04	5·45	5·28
290	3·41	3·25	5·67	5·52
330	3·57	3·43	5·84	5·74
370	3·57	3·59	5·89	5·96
410	3·65	3·72	6·06	6·15
450	3·73	3 85	6·23	6·34
490	3·80	3·94	6·39	6·52
530	3·88	4·01	6·50	6·63
570	4·04	4·06	6·72	6·83
610	4·20	4·09	7·06	6·97
650	4·20	4·10	7·18	7·09

The thermal behaviour of IrO_2 is similar to that of CoF_2[6] and rutile type GeO_2[7] in having a negative thermal expansion anisotropy, *i.e.*, $\alpha_{\perp} > \alpha_{\parallel}$. For most of the rutile type compounds so far studied it was found that $\alpha_{\parallel}$ is greater than $\alpha_{\perp}$.

The authors acknowledge their sincere thanks to Dr. W. D. Ryden of the University of California for kindly supplying the sample used in the present study. Grateful thanks are also extended to the Council of Scientific and Industrial Research, New Delhi, for the sanction of a research scheme.

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SINGLE CRYSTAL TRANSFORMATION OF ORTHORHOMBIC Sb_2O_3 TO ORTHORHOMBIC Sb_2O_4

P. S. GOPALAKRISHNAN AND H. MANOHAR

Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore-12, India

ABSTRACT

The transformation of orthorhombic Sb_2O_3, valentinite, to orthorhombic Sb_2O_4, cervantite has been studied by single crystal X-ray diffraction techniques. The reaction has been found to be topotactic. The orientation relationships and the similarity of the two structures have been established.

ANTIMONY TRIOXIDE (Sb_2O_3) exists in two crystalline forms, the low temperature cubic senarmontite and the high temperature orthorhombic valentinite, with a transition temperature of approximately 573° C.[1] Antimony tetroxide (Sb_2O_4) has also been found to exhibit polymorphism. Apart from the orthorhombic form, cervantite,[2] a high temperature monoclinic variety has also recently been identified.[3] Sb_2O_4 can be obtained by the oxidation of Sb_2O_3 in air.[4] However, no detailed structural studies on the conversion have been reported. We have studied the transformation of valentinite to cervantite by single crystal X-ray diffraction techniques, established the orientation relationships between the two and deduced their structural similarity, which we report here.

The structure of valentinite, determined by Buerger,[5] is composed of infinitely long chains of Sb_4O_6 groups, alternate chains in the unit cell running antiparallel. Within the chain each antimony is linked to 3 oxygens and each oxygen to 2 antimony atoms. The chains are held together in the crystal by secondary weak Sb-O bonds. The structure of cervantite has not been determined so far for lack of suitable single crystals.[3] However, the structure of isostructural $SbNbO_4$ has recently been established by Skapski and Rogers.[6] Prof. Rogers has kindly sent us the atomic co-ordinates for $SbNbO_4$ prior to publication[7] and we have used these in the following discussion. The cell dimensions for Sb_2O_4 as well as Sb_2O_3 have been taken from N.B.S. data.[8] Sb_2O_4 is actually $Sb^{III}Sb^{V}O_4$ and its structure consists of corrugated sheets of $Sb^{V}-O$ octahedra linked by sharing corners and running parallel to (010).* Adjacent sheets of these octahedra are joined by Sb^{III} atoms which are thus bonded to 4 oxygen atoms. Crystallographic data for the two oxides are tabulated in Table I.

TABLE I

Crystallographic data for valentinite and cervantite

	Valentinite, Sb_2O_3	Cervantite, Sb_2O_4*
a	4·914 Å	4·810 Å
b	12·468 Å	11·76 Å
c	5·421 A	5·436 Å
Z	4	4
Space group	Pccn	$Pc2_1n$

Single crystals of valentinite, of size suitable for X-ray work, were prepared by heating Sb_2O_3 powder of semiconductor purity at 630° C., *i.e.*, just below its melting point, in a platinum container placed inside a sealed pyrex glass tube. Crystals of valentinite were converted into cervantite by heating in the presence of air in a tubular furnace at temperatures around 490° C. for different intervals of time. The crystals were then air-quenched and examined by X-ray rotation and Weissenberg techniques. These photographs reveal spots corresponding to interpenetrating reciprocal lattices of valentinite and cervantite, indicating that a crystal of valentinite which is incompletely oxidised gives a 'hybrid' crystal of the two oxides. With increased time of oxidation the amount of cervantite in the hybrid increases and finally pure cervantite crystals are obtained. At 490° C., the transformation was complete in about 8 hours. Analysis of the photographs of the hybrid crystal shows that the crystallographic axes *a*, *b* and *c* of valentinite (*v*) are respectively transformed into the *a*, *b* and *c* axes of cervantite (c). The following orientation relationships are thus established:

$$[100]_v \parallel [100]_c$$
$$[010]_v \parallel [010]_c$$
$$[001]_v \parallel [001]_c$$

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* The crystallographic axes of Skapski and Rogers have been interchanged to facilitate comparison with Sb_2O_3.

It is now of interest to compare the two structures, keeping in view the experimental result that the individual axes are parallel. Two projections of the valentinite and cervantite structures along [100] and [001] are shown left and right respectively in Figs. 1 and 2. In both projections one can identify the Sb_4O_6 group corresponding to valentinite and designated Sb(1) 0(2) Sb(3) 0(4) Sb(5) 0(6) Sb(7) 0(8) 0(9) 0(10) in cervantite. It is therefore evident that the relative positions of atoms in valentinite are more or less preserved in cervantite. The only two additional atoms in the latter are 0(11) and 0(12). As the [001] projection clearly shows, the valentinite structure has channels between the $(Sb_4O_6)_\infty$ chains parallel to the c axis and these additional oxygen atoms occupy positions along these channels close to the antimony atoms. Each oxygen links up two antimony atoms of neighbouring chains along [100]. For example 0(11) bonds with Sb(1) and Sb(3) and 0(12) with Sb(3) and Sb(1) of the neighbouring cell. Sb(1) and Sb(3) also form additional bonds to oxygens 0(2′) and 0(9′) respectively of a neighbouring anti-parallel chain, these being the secondary weak bonds described by Buerger in valentinite. As a result Sb(1) and Sb(3) acquire a distorted octahedral co-ordination. The contraction in a and b dimensions as a result of the transformation is easily understood on the basis of a closing up of the chains along these directions. The conversion of the chain structure of valentinite into the three-dimensional structure of cervantite also follows from the above arguments. Exactly similar changes take place in the other half of the unit cell because of the two extra oxygen atoms 0(11′) and 0(12′).

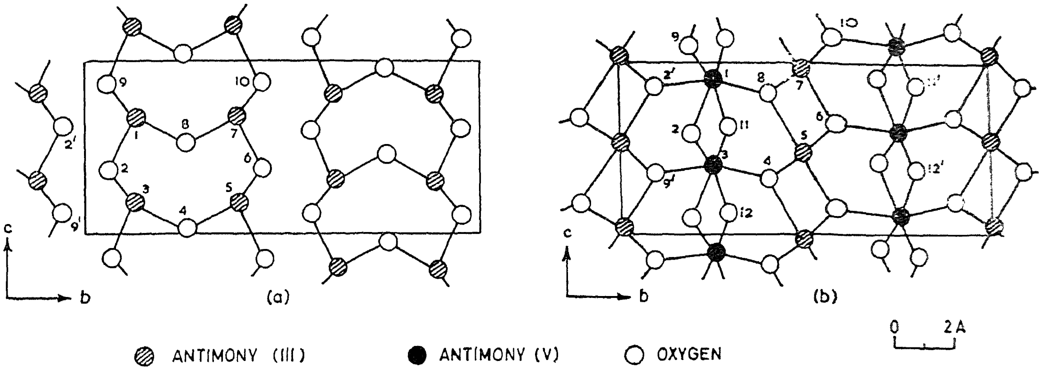

FIG. 1. Structures of valentinite (*a*) and cervantite (*b*) projected along [100].

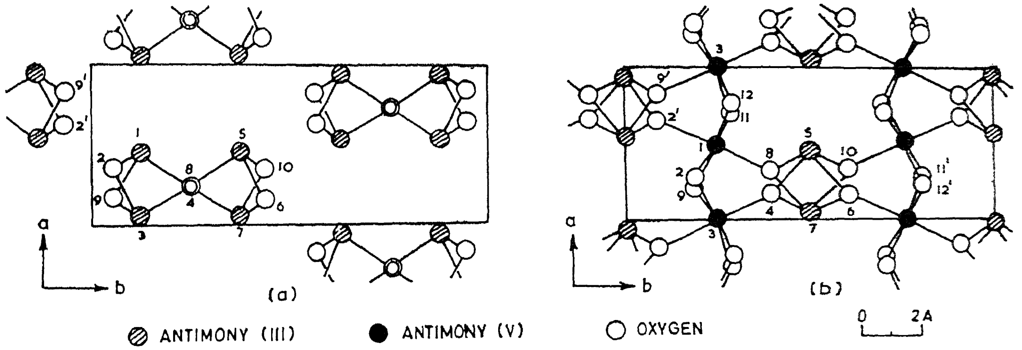

FIG. 2. Structures of valentinites (*a*) and cervantite (*b*) projected along [001].

In view of the close structural relationship in three dimensions between valentinite and cervantite, this transformation is obviously a topotactic reaction.[9-11] A more detailed understanding of the mechanism of this transformation should await the results of kinetic and optical studies and the crystal structure analysis of cervantite which are being undertaken.

ACKNOWLEDGEMENT

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SCAVENGING OF NUCLEAR FISSION PRODUCTS BY SEAWEEDS FROM SEA-WATER

(MISS) J. M. PAREKH, S. T. TALREJA, B. J. BHALALA AND Y. A. DOSHI

Central Salt and Marine Chemicals Research Institute, Bhavnagar

LIFE has developed on earth in conditions of continual exposure to low levels of ionizing radiations referred to as natural radioactivity. But with the advent and utilization of nuclear energy for peaceful purposes and the increasing use of radionuclides and ionizing radiations in scientific research, in industry, medicine and agriculture involving the production of large amounts of radioactive waste, there arises a new parameter namely the determination of the extent of harmful effects of the above factors on man and elimination of this effect. The removal of radioactive fission fragments and waste material from the contaminated sea-water, area and species has been a problem and so far, the techniques used involve complexing with chemical reagents like EDTA.[1] It is known[2,3] that certain seaweeds have a specific capability to concentrate various trace elements and it is now thought to profitably use the seaweeds as scavengers of contaminated radioactivity since their removal from the medium is simple. A successful method for the removal of radioactive fission fragments Sr^{90}, Cs^{137}, Ru^{106}, I^{131} and Zn^{65} (waste product) from contaminated sea-water specially meant for desalination and drinking purposes, using marine and freshwater algæ has been tried and is described below.

A stock solution of filtered sea-water containing about 0·02 μc./l. (500–600 cpm./ml.) of the respective radionuclide (Sr^{90}, Cs^{137}, Ru^{106}, I^{131} and Zn^{65}) was prepared for the scavenging experiments. To fifty millilitres of the above sea-water one gram of fresh algal material, collected from Okha and Veraval coasts, was added after it was washed with tap-water and blotted dry. In some cases, ten gram of algal material was taken in 500 ml. of sea-water. A couple of samples were kept in dark while others were exposed to direct sunlight (*Ca* 3375 ft. candles) for 30, 60 and 120 minutes. The algal sample (W) was immediately removed, washed with alcohol, dried at 105° C., powdered and counted. The left over (A') and original (A) radioactivities in sea-water was measured by pipetting out 1 ml. (W') of it into a plastic tube (γ–) or S.S. planchet (β—4·91 sq. cm.) and counted for γ-activity in a GRS 20 B, γ-ray spectrometer (ECI) and β-activity with a F.H. 90 scaler. From the data thus obtained, the percentage activity scavenged by each seaweed was calculated as

$$\% S = W(A - A')/W'A \,.\, 100$$

Practically all the available marine algæ of the west coast were tried and the effect of temperature, pH and light on scavenging were also studied.

It is seen from Table I that about 50% of the activity can be removed from contaminated sea-water by selecting the appropriate algal species for each of the radionuclides. Thus, whereas green algæ scavenge a maximum of about 60–90% of Zn^{65} (*Enteromorpha* sp. 97%) brown algæ remove about 20–30% of Sr^{90} (*Sargassum* johns) and I^{131} (*Cystoseira* sp. 40%). Ruthenium-106 and cesium-137 nuclides cannot be effectively scavenged by marine algæ for reasons arising from theoretical considerations and discussed below. However, about 62% of Cs^{137} can be easily removed from the medium by using freshwater algæ and similarly Sr^{90} can be more effectively scavenged upto (43%) by marine fish (10–15 g.). The rate of scavenging is optimum around ambient temperatures, sea-water pH (7·9) and at higher light intensities especially so with Zn^{65} and I^{131}. However, these parameters do not influence the overall per cent scavenged so much as to be of significance.

TABLE I

Scavenging of radioactive fission products by seaweeds

1 gm./50 ml. (biomass 2 × 10^4 g./m.^{3}) sea-water, exposed to sunlight for 1 hr. (40,000 lux.)
Radioisotope scavenged/g. (S%) = W(A − A′)/W″A 100.

Algal species	Cs-137		Sr-90		I-131		Zn-65		Ru-106	
	%	μ μc × 10^{-2}	%	μ μc × 10^{-2}	%	μ μc × 10^{-2}	%	μ μc × 10^{-2}	%	μ μc × 10^{-2}
(*a*) *Seaweeds*										
Brown :										
(1) *Padina* sp. ..	..	..	..	..	..	..	46·00	51	..	..
(2) *Sargassum* johns ..	4·5	4·9	26·6	20	18·3	21·2	21·00	17	9·6	8·4
(3) *Cystoseria* sp. ..	..	..	29·6	21	40·7	34·0	60·00	55	9·5	8·1
(4) *Myriogloea* sp. ..	..	..	10·54	9·1	25·7	25·6	..	..	8·4	6·8
(5) *Dictyopteris* sp. ..	..	..	27·40	20·4	2·7	2·4	..	..	..	..
Red :										
(6) *Hypnea* sp. ..	..	..	..	..	..	..	16·4	21	15·2	13·8
(7) *Laurentia* sp. ..	..	..	..	..	..	..	55·1	64	..	..
(8) *Gelidiella* ace ..	9·2	23	..	..	..	..	..	..	..	..
(9) *Gracilaria* millar ..	6·1	14	20·7	17·0	11·96	2·3	..	..	..	..
(10) *Aspergosis* sp. ..	..	..	16·23	10·3	25·40	24·1	..	..	..	..
(11) *Sarconema* sp. ..	..	..	7·30	6·3	5·90	..	..	..	..	..
Green :										
(12) *Ulva* fasc. ..	3·0	4·7	15·2	13	14·3	17·0	64·0	83	17·4	..
(13) *Enteromorpha* sp. ..	..	..	16·4	15	15·4	18·3	97·14	103	..	..
(14) *Acetabularia* sp. ..	..	..	..	..	..	..	62·87	67	..	..
(15) *Caulerpa* sp. ..	..	..	..	..	..	..	4·10	1·0	..	..
(16) *Cladophora* sp. ..	..	..	..	..	..	..	52·10	62	..	..
(*b*) *Freshwater pond algæ*										
Mix. of *Phormidium* Kutz. *Gloetrichia* Ag (g) and *Cosmarium* sp.	62	120	..	..	..	..	..	..	..	..
(*c*) *Marine fish*	..	..	43·00	450	..	..	..	..	13	60

The observed selective behaviour of various marine algæ and their scavenging capabilities can be explained and even predicted from a knowledge of concentration[4] (K), elimination and discrimination factors for various radionuclides. This also depends on the state in which the elements are existing in sea-water as well as biological features of the organisms, the amount of radionuclide present (optimum at 10^{-10} to 10^{-11} curies) and finally on the concentration of the algæ in sea-water (biomass, ppm or g./m^3). Thus, (1) if the concentration factors (K) for the particular radionuclide are known, then the percentage activity scavenged can be given[5] as

$$S = \frac{K}{K + \dfrac{1}{10^{-6} B}} \cdot 100$$

where B is the biomass g./m.^{3} and is given by $P/10^{-6} P'$ where P and P′ are respectively weights of the organisms and water. Thus, applying the above expression to Zn^{65} scavenging with $B = 2 \times 10^4$ g./m.^{3} and with high concentration factors for Zn^{65} (K is directly proportional to light in this case) we obtain 50% scavenging for a concentration factor of 100 and about 90% for K = 1000. On the other hand, with Cs-137 the concentration factors are very low and further since K^6 depends on the potassium/cesium ratio in sea-water which is very high (380 × 10^3), it follows that very little scavenging is expected. But with freshwater algæ, the potassium/cesium ratio is considerably altered, raising the K value and hence more scavenging from the above expression.

Secondly, a knowledge of discrimination factor, *i.e.*, $Da/b = K_a/K_b$ where a and b are the elements present in the medium, is essential. The ratio of Ca/Sr depends on the discrimination factor and for example brown algæ prefer Sr to Ca (*cf.* Table I) since Sr–Ca discrimination ratio is 4·2 whereas that for red algæ is 1·3 (green 0·5). In sea-water, Ca is 50 times more than Sr and hence $K_{Sr} = 0 \cdot 02\ K_{Ca}$, so unless appreciable amounts of Ca are removed it is impossible to scavenge any more Sr^{90} from the medium.

Thirdly, elimination factor, *i.e.*, the amount of radionuclide eliminated simultaneously when the seaweed is concentrating it, also plays an important part. This effect is negligible[2] with Zn^{65}, Sr^{90} (10–15%) and has no effect with Cs^{137} and I^{131}, whereas with Ru^{106} it is considerable. Thus with Ru^{106} and Ulva fasc. the elimination is as high as 60% and hence low percentage of scavenging. The small scavenging effects observed (*cf.* Table I) are ascribed to Ru^{106} existence in particulate form (90%) and formation of a soluble complex with iron hydroxide present in sea-water.

Finally, concentration of an organism in a given area known biomass plays an important role in scavenging. A biomass of 2×10^4 g./m.^{3} as employed in the present case is far too much to be expected in natural conditions. Hence decontamination is only possible in small areas of the biosphere and not in the biosphere as a whole. The specificity of a particular seaweed for scavenging makes its use a less profitable proposition, but the complexing agent EDTA is no better and can scavenge little Zn^{65} I^{131} and Ru^{106} and particularly no Cs^{137} and Sr^{90}. Although this method is impracticable on a large scale, it can still be employed safely where desalination methods are used to decontaminate salt, etc., for drinking water purposes on a limited scale in emergency.

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LUNAR ATLAS*

THE limited original edition of this work was heralded as one of the bibliographical events of 1961, for the book contains many of the most magnificant photographs of the lunar surface. Large, and, in almost every case, one-to-a-page, these photographs show us overall and sharply detailed views that are authoritative as well as beautiful. The faithful reproduction and the full text make this a unique atlas, a valuable addition to the layman's library, and a helpful guide to the amateur observer, the astronomer, and the space scientist.

The photographs, taken by the Mt. Wilson, Lick, Palomar, Yerkes, and McDonald observatories, as well as French and Russian ones, are grouped into five sections. 21 plates show overall views of the moon, following it through crescent, full, and waning phases; 2 plates—mounted on a grid for identification of the lunar features—depict the waxing and waning of the half moon; 9 plates divide the lunar surface into twelve overlapping sections; 106 plates concentrate on the most interesting lunar features; 9 plates—including two views of the lunar farside as photographed by Russia's Lunik III—have historical significance as well. The majority of these plates are printed one to a large-sized (10½ × 12-3/4) page.

The text that accompanies these photographs is fully documented. The difficulties of lunar photography, the effects of foreshortening and of the moon's librations and the position of the sun, the observatories from which the photographs were made, date and time of exposure, the phase of the moon at the time, the colongitude, orientation of the lunar meridian, tests for distinguishing between closely related formations, clues to the moon's history and the forces which must have shaped its topography—these are only some of the topics touched upon.

C. V. R.

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* *Lunar Atlas*. Edited by Dinsmore Alter. (Dover Publications, Inc, 180, Varick Street, New York, N.Y. 10014, U.S.A.), 1963. Pp. z+ 343. Price $ 5.

LETTERS TO THE EDITOR

EFFECTIVE ATOMIC NUMBERS FOR PAIR-PRODUCTION PROCESS IN ALLOYS

HINE[1] pointed out that the effective atomic number for gamma-ray interactions in alloys cannot be represented by a single number and for each partial process the number has to be determined separately. He suggested that the effective atomic number for pair-production process, $\bar{Z}$, can be represented by expression (1)

$$\bar{Z} = \sum_i p_i Z_i \qquad (1)$$

where p_i and Z_i are the proportions and the atomic numbers of the individual elements with which the alloy is composed. The present attempt is to verify these predictions utilising experimental data.

Experimental pair-production cross-sections in individual elements are obtained by subtracting the theoretical photoelectric cross-sections reported by Hubbell and Berger[2] and coherent and incoherent scattering cross-sections reported by Brown[3,4] from the experimental total gamma-ray cross-sections of Colgate[5] at gamma energies 4·47, 6·13 and 17·6 MeV. Utilising these values the pair-production cross-sections in three alloys, namely, Linotype Metal (Pb, 79% ; Sb, 16% ; Sn, 5%), Solder Soft (Pb, 40% ; Sn, 60%) and Pewter (Sn, 85% ; Cu, 7% ; Bi, 6% ; Sb, 2%) are estimatel making use of expressions (2) and (3).

$$\left(\frac{\mu}{\rho}\right)_{\text{alloy}} = \sum_i W_i \left(\frac{\mu}{\rho}\right)_i \qquad (2)$$

$$(\mu_a)_{\text{alloy}} = \frac{\left(\frac{\mu}{\rho}\right)_{\text{alloy}}}{N \sum \frac{W_i}{A_i}} \qquad (3)$$

where $(\mu/\rho)_{\text{alloy}}$ and $(\mu_a)_{\text{alloy}}$ are respectively the pair-production mass absorption coefficient and atomic cross-section of alloy. N is the Avogadro Number. $(\mu/\rho)_i$, W_i and A_i are respectively the mass absorption coefficients, proportional weights and atomic weights of the individual elements with which the alloy is composed. The denominator of the right-hand side of expression (3) gives the number of atoms of the alloy per gram. In Sb the cross-sections are obtained by interpolations from the available data. Utilising these cross-sections the effective atomic numbers for pair-production process are determined by interpolations from the plots—pair-production cross-sections *vs.* atomic number of the elements, at the three energies. These numbers along with those obtained from expression (1) are given in Table I. It can be seen from Table I that the effective atomic numbers remains, more or less, constant at the three energies for each alloy and these values are in satisfactory agreement with the predicted values of Hine[1] within the limits of errors. Thus the present findings provide an experimental verification of Hine's[1] predications.

TABLE I

Effective atomic numbers for pair-production process in alloys

Name of the alloy and composition	Energy in MeV	Effective atomic numbers	
		Present values	Values from expression (1)
Linotype metal ..	4·47	74·3 ± 2·0	
	6·13	74·5 ± 1·5	75·4
	17·6	74·1 ± 1·0	
Solder soft ..	4·47	61·5 ± 2·5	
	6·13	61·2 ± 2·0	62·8
	17·6	61·0 ± 1·5	
Pewter ..	4·47	49·7 ± 3·0	
	6·13	49·4 ± 2·0	50·5
	17·6	49·3 ± 1·5	

Laboratories for Nuclear Research, — K. NARASIMHA MURTY.
Andhra University, — K. PARTHASARADHI.
Waltair, India, — SWAMI JNANANANDA.
March 4, 1969.

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OXIDATION OF SOME ORGANIC COMPOUNDS BY COBALTIC ION

WE reported earlier[1,2] that Co^{3+} oxidised a wide variety of organic compounds like acetone, ethyl methyl ketone, tetrahydrofuran, dioxane, etc. We now report kinetic results on the oxidations of pinacol, propane-1, 2-diol, propane-1, 3-diol, glycerol sorbitol, mannitol, cyclopentanone, glycolic acid, sucrose and fructose by cobaltic sulphate in H_2SO_4 medium and glutaric acid by cobaltic perchlorate in $HClO_4$ medium at $5 \pm 0°$ C. to $25 \pm 0{\cdot}1°$ C., $[H^+] = 2{\cdot}0$ M and ionic strength $\mu = 2{\cdot}1$ M ($[H^+] = 4$ M and $\mu = 4{\cdot}1$ M for sucrose and fructose only). All the substrates were of Analar grade. Method of preparation and details for following rate of Co^3 ion disappearance are the same as described previously.[3]

Our experimental results are: (*i*) All the reactions studied are second order, first order each with respect to $[Co^{3+}]$ and substrate except in the case of glutaric acid where Michaelis-Menten kinetics was observed:

$$\frac{1}{k_{obs.}} = \frac{1}{k_t} + \frac{[H^+]}{k_t\,K\,[\text{Glutaric}]}$$

(ii) Experimental results would be fitted into the main form of the rate law, $k_2 = a + b/[H^+]$ (Table I) for all the substrates except for sucrose and fructose. $[H^+]$ increased the rate of oxidation of sucrose while fructose oxidation showed the interesting feature of an inverse acidity dependence upto 2·0 M and direct acidity dependence from 2·0 M to 4·0 M.

(*iii*) $[HSO_4^-]$ and μ retarded the rate of oxidation of all substrates and plots of k_2-1 *vs.* $[HSO_4^-]$ and log k_2 *vs.* $\mu^{\frac{1}{2}}$ were linear.

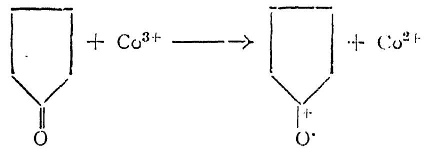
TABLE I

Substrate	$k_2 \times 10^2$. M^{-1} sec^{-1} at 15° C.	ΔE K cals/ mole	$\Delta S^{\ddagger}$ e.u/ mole	A M^{-1} sec^{-1}
Pinacol ..	9·166	26·69	29·40	$1{\cdot}593 \times 10^{19}$
Propane-1, 2-diol	66·85	27·52	36·18	$4{\cdot}843 \times 10^{20}$
Propane-1, 3-diol	37·50	26·69	32·21	$6{\cdot}516 \times 10^{12}$
Glycerol ..	106·7	31·20	49·92	$4{\cdot}877 \times 10^{29}$
Sorbitol ..	135·7	31·20	50·39	$6{\cdot}203 \times 10^{33}$
Mannitol ..	110·0	31·06	49·46	$3{\cdot}903 \times 10^{23}$
Cyclopentanone ..	1·419	21·20	6·609	$1{\cdot}666 \times 10^{14}$
Glycolic acid ..	50·00	26·86	33·32	$1{\cdot}46 \times 10^{20}$
Sucrose ..	69·44	21·35	14·93	$1{\cdot}075 \times 10^{16}$
Fructose ..	48·44	26·69	32·71	$8{\cdot}418 \times 10^{19}$
Glutaric acid*	$k_t = 0{\cdot}1111 \times 10^{-2}$ sec.$^{-1}$ $K = 12{\cdot}3$	28·16	25·70	$2{\cdot}487 \times 10^{18}$

* $HClO_4$ medium.

We conclude that (*i*) oxidations of polyhydric alcohols and carbohydrates are comparatively faster than those of ketones and that mechanisms involving C–H bond fission or C–C bond fission[1] may be suggested for the polyhydric alcohols,

(*ii*) The keto form of cyclopentanone may be active since oxidation rate >> enolisation rate[4] and the path of oxidation may be:

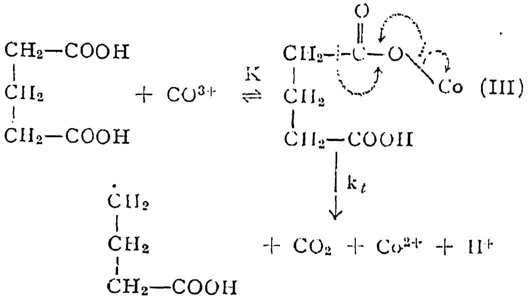


(*iii*) The kinetic features of oxidation of glycolic acid are very similar to those of diglycolic acid[1] and the probable mechanism may be:

$CH_2OH.COOH + Co^{3+} \rightarrow \dot{C}H_2OH + CO_2 + Co^{2+} + H^+$

$\dot{C}H_2OH + Co^{3+} \rightarrow HCHO + Co^{2+} + H^+$

(*iv*) Glutaric acid whose oxidation obeyed Michael-Menten kinetics was probably oxidised by the route:



(*v*) The large positive entropies of activation, high values of A and energies of activation 21 to 31 K.cals/mole are quite in accordance with those[5,6] for the reactions involving Co^{3+}.

Department of Physical Chemistry,
University of Madras,
Madras-25, *March* 12, 1969.

A. MEENAKSHI.
M. SANTAPPA.

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CAUSES OF LARGE-SCALE VARIATIONS IN THE SOUTH-WEST MONSOON RAINFALL OVER THE INDIAN SUBCONTINENT

In a recent article in this journal Ramaswamy[1] has concluded that the important basic causes of the large-scale deficiency in the monsoon rainfall in 1965 and 1966 have to be sought for in the middle and upper tropospheric westerlies and easterlies and in the abnormalities created by them. In this connection, a reference is invited to the lecture delivered by the author at the same meeting,[2] important points from which are given in what follows.

The basic conditions which one notices in a typical monsoon month like July for the subcontinent are the presence of (*i*) a low pressure over the West Pakistan, (*ii*) a trough of low pressure over the Gangetic Valley and (*iii*) south-westerly winds both over the Arabian Sea and the Bay of Bengal. As shown by Banerji[3] the topographical features of the subcontinent are responsible for the location of the heat-low and development of the monsoon trough, and their influences extended upto about 4·0 km., thus making the monsoon circulation self-sustaining in the lower levels of the atmosphere.[4] The monsoon circulation can be set up in the lower levels of the atmosphere (upto about 4 km.) *without* any changes in the middle and upper tropospheric westerlies and easterlies as would appear from the evidences given below :

(*a*) Ramamurthi and Keshavamurthy[5] have stated that during 1963, the Tibetan high was established much later after the onset of the monsoon.

(*b*) Ramamurthi and Jambunathan[6] have shown that the disintegration or the northward shift of the upper tropospheric westerly maximum over North India or the appearance of strong upper level easterlies over extreme south of the Peninsular India are *not* the prerequisite conditions for ushering the monsoon rains.

(*c*) According to Ananthakrishnan[7] the subtropical anticyclone in the upper troposphere lay between 20 and 25° N. to the south of the Tibet plateau when the monsoon first set in and it took some five to six weeks for the monsoon to get fully established over India, and it was *then only* that the subtropical ridge shifted to about 30° N.

(*d*) Ramamurthi[8] has shown that the easterlies over the Peninsula during strong monsoon conditions were *weaker* than usual at 300 and 200 mb level.

While recognising that the large-scale changes in the middle and upper tropospheric westerlies and easterlies influence performance of monsoon, it has to be realized that establishment of the basic monsoon circulation in the lower levels of the atmosphere is *essential* as without the same the influences of the former would be of the type as in the months October to May. The heat-low over the West Pakistan is there throughout the monsoon season, but without the presence of the moist south-westerly current over both the Arabian Sea and the Bay of Bengal, the Gangetic Valley trough will not develop. The basic monsoon circulation is affected by (*i*) surges of falling pressure over Asia which include perturbations in both the westerly and easterly currents, (*ii*) surges of rising pressure near the equator which are due to conditions in the southern hemisphere and affect the flow of air across the equator into the Indian Seas ; and (*iii*) conditions over Africa which inject cyclonic vorticity in the monsoon current over the Arabian Sea.[2-9] The weather realized is the integrated effect of the above factors on the basic monsoon circulation and unless a study of the influences of *all the factors* on it is made, one may not be able to come to correct conclusions about the causes responsible for either excessive or deficient precipitation during short or long periods of the season.

173, Swami Vivekananda Road, B. N. Desai.
Vile Parle (West),
Bombay-56, *March* 4, 1969.

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IN VITRO UPTAKE OF *dl*-VALINE-1-C^{14} BY DIFFERENT PARTS OF THE RABBIT FALLOPIAN TUBE

PARTS of the Fallopian tube has been reported to differ histologically in some mammals.[1,2] Biochemically, the ampulla (A) has a more pronounced alkaline phosphatase activity than that of the isthmus (I) in both rats[3,4] and rabbits.[5] On the other hand, acid phosphatase activity is maximal in the ampullary-isthmic junction (AIJ).[5] The concentration of lipids and electrolytes (sodium, potassium and chloride) is lowest in this area, while that of calcium is highest in the I.[6] The present report deals with the uptake of *dl*-valine-1-C^{14} by the three portions of the rabbit Fallopian tube.

Colony-bred adult virgin rabbits (1·5–2 kg.) were used in this investigation. They were maintained in air-conditioned quarters (75 ± 2° F.) under standard husbandry conditions prior to sacrifice. The anatomic demarcation of the parts of the Fallopian tube was done by the procedure described previously.[5] The tissues (50–60 mg. of each part) were incubated with 1 μc. of *dl*-valine-1-C^{14} (Bhabha Atomic Research centre, Trombay) and subsequently processed for incorporation of radioactivity into protein by the procedure of Little and Lincon.[7] Counting was done in a LSC-10 B Tracer Lab. scintillation spectrometre according to the method of Hadi and Krishna Murti,[8] and Bousquet and Christian.[9] The counting efficiency was 40–45% for C^{14}. The results are expressed as counts/minute/100 mg. dry protein (Table I).

TABLE I

Uptake of dl-*valine-1-C^{14} by different parts of the rabbit Fallopian tube*

Part of the Fallopian tube	Cpm./100 mg. dry protein (mean ± S.E.)
Ampulla (A)	245,000±17,400 (*11*) *
Ampullary-isthmic junction (AIJ)	202,900±11,600 (*10*)
Isthmus (I)	161,900,±13,500 (*9*)

* No. of animals in parenthesis.

It will be evident from the results presented in Table I that of the three parts of the tube, A showed the maximal incorporation of the amino-acid (*vs.* AIJ – $P < 0·05$; *vs.* I – $P < 0·01$). There was no significant difference between the AIJ and I in this respect.

The results of the present and previous studies[5] suggest that the turnover of protein is highest in A in comparison to other parts of the rabbit Fallopian tube. This is probably related to the high secretory activity of A; in this species the tube is known to secrete mucin,[10] but whether the rate of its secretion is different in the three parts has not been determined. It is pertinent to note that in ewes the Fallopian tube is also known to elaborate mucin; the A part shows greater secretory activity than the I part. This is indicated by the presence of more secretory epithelial cells[11] in the A with large cytoplasmic area and prominent vesiculations.[2] Likewise, in ovariectomized rabbits subjected to estrogen therapy the height of the secretory epithelium of the A area has been shown to be greater than that of the I.[12]

This investigation was supported by a grant by the Ministry of Health, Family Planning and Urban Development, Government of India. The authors are grateful to Dr. M. L. Dhar for his interest in this study.

Central Drug Res. Institute,
Lucknow,
January 27, 1969.

S. K. ROY.
D. N. GUPTA.
J. N. KARKUN.
AMIYA B. KAR.

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THE USE OF GUINEA-PIGS IN THE POTENCY TESTING OF MALLEIN

THE standardization of mallein is conventionally performed in ponies sensitised with *Actinobacillus mallei*. In order to avoid the obvious disadvantages and limitations of this method of determination of potency of the product an alternative method for this purpose, using laboratory small animals, was tried. The observations made in this context are presented here.

TABLE I

Allergic response in guinea-pigs with China 5 mallein

Days of testing / Guinea pig number	10th day				15th day				20th day				25th day				35th day			
	MALLEIN				MALLEIN				MALLEIN				MALLEIN				MALLEIN			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Group A (Live culture)																				
No. 357	–	–	–	–	±	±	–	–	++	++	+	–	+	–	+	+	+	+	–	–
No. 1143	–	–	–	–	±	±	–	–	+	+	–	–	+	+	–	–	–	–	–	–
No. 1155	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–
Group B (Inactivated culture)																				
No. 774	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 587	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 594	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

A = China 5 mallein 1 in 10 dilution ;
B = China 5 mallein 1 in 100 dilution ;
C = China 5 mallein 1 in 1000 dilution ;
D = China 5 mallein 1 in 2000 dilution.

+ = Mild reaction ;
++ = Marked reaction ;
– = No reaction.

Three male, healthy guinea-pigs, each weighing about 200 gm., were injected intramuscularly with 1 ml. of a thick suspension of 72 hours growth of *A. mallei* strain China 5 on glycerine dextrose agar at 37° C. The second group of three guinea-pigs of similar description received 1 ml. of heat killed (60° C. for 1 hour) suspension prepared in the same manner. The route of administration was intramuscular. Both the groups of guinea-pigs were tested for their sensitivity to mallein on the 10th, 15th, 20th, 25th and 35th days after inoculation with culture. For this purpose, each animal was injected intradermally with 0·2 ml. of 1 : 10, 1 : 100, 1 : 1000 and 1 : 2000 dilutions (made in isotonic saline) of intradermo-palpabral mallein prepared from *A. mallei* strain China 5 which had previously been declared potent on the basis of tests in sensitised ponies. The results presented in Table I would show that the dilutions of mallein ranging upto 1 : 100 provoked marked cutaneous reaction in guinea-pigs on the 20th day of inoculation with living culture of *A. mallei*.

In order to confirm the above observations another trial was made. The guinea-pigs which received the live cultures were inoculated again with a similar dose of live culture. Four more healthy guinea-pigs of similar description were also injected intramuscularly with 1 ml. of thick suspension (3% transmittancy using filter 61 in Heilger type absorptiometer) of 72 hours growth of *A. mallei* strain China 5. All these seven guinea-pigs along with two healthy uninoculated ones were tested intradermally on the 20th day post-inoculation with 0·2 ml. of 1 : 10, 1 : 25, 1 : 50 and 1 : 100 dilutions (made in isotonic saline) of the mallein. The results are presented in Table II. It would appear that the mallein of requisite potency in sensitised equines also elicited marked cutaneous reaction in dilutions of 1 : 10 and 1 : 25, in guinea-pigs sensitised with live cultures of *A. mallei*. The degree and extent of reactions were found to decrease with further dilution of mallein. Individual guinea-pig variation was also seen in the manifestation of allergic response. None of the two healthy controls elicited cutaneous reaction.

TABLE II

Allergic response in guinea-pigs on 20th day of sensitisation

Antigen / Animal No.	China 5 mallein dilutions			
	1 : 10	1 : 25	1 : 50	1 : 100
1155	++	–	–	+
357	++	++	++	++
1143	+	+	+	+
1569	+++	+++	+++	+++
1561	+++	+++	++	+
1577	+	+	–	–
1567	+++	+++	++	++
Uninoculated healthy control	–	–	–	–

+++ = Maximum reaction ;
+ = Mild reaction ;
– = No reaction.

The earlier unsuccessful attempts by Rice and Konst (1952) to sensitize guinea-pigs by intraperitoneal inoculation of live cultures of

A. mallei cannot be explained at this stage. The present observations point to the possibility of employing guinea-pigs in the standardisation of mallein for which purpose a method of statistical evaluation of potency of the product can be developed.

Division of Bacteriology and Virology,
Indian Veterinary Research Institute,
Mukteswar-Kumaon (U.P.),
February 22, 1969.

C. R. MARATHE.
G. P. SEN.
GAJINDAR SINGH.
S. KUMAR.

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ISOSPORA GYPSI N. SP. A NEW COCCIDIUM FROM THE INDIAN VULTURE (*GYPS BENGALENSIS*)

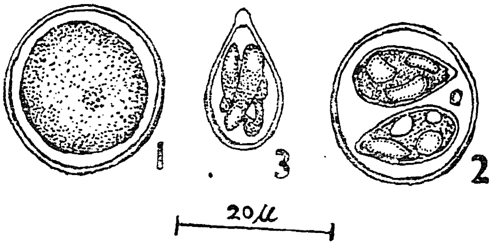
INDIAN vulture (*Gyps bengalensis*) does not seem to be a known host for coccidian parasites.[1–3] While conducting autopsy of a vulture to investigate into the chain toxic reaction of an insecticide, a few coccidian cysts in the fæcal sample were encountered. An attempt was made to study them from six more fæcal samples collected from another place and maintained in 2% potassium dichromate solution.

The coccidium was found to be a new species of the genus *Isospora* Schneider, 1881, and is designated *I. gypsi* after the generic name of the host.

Isospora gypsi N. SP.

(The measurement given are taken from 25 specimens)

The oocysts were smooth-walled, subspherical in shape and had no visible micropyle. They measured 17·5 to 22·4 µ (mean 20·2 µ) in length and 14 to 19·6 µ (mean 18 µ) in breadth with a shape index (Length/breadth) of 1·03 to 1·6 (mean 1·1). The sporont almost filled the inner space (Fig. 1).



FIGS. 1–3

They sporulated in about 18 to 20 hours into two pyriform tetrazoic sporoblasts leaving an irregular oocystic residuum of 2 µ diameter (Fig. 2). Each sporocyst measured 11·2 to 16·8 µ (mean 13·5 µ) in length and 8·4 to 9·8 µ (mean 8·9 µ) in breadth, had a refractile conical stidæ body at the narrow end and contained four sporozoites of 6 × 1·5 µ size and a granular sporocystic residuum (Fig. 3).

Remarks.—In the family Accipitirdiæ, only *I. buteonis* Henry, 1932 has so far been described from a falcon in America, and there is no other oriental report.[1] The coccidium under consideration is much larger than *I. buteonis* (16–19·2 µ × 12·8–16 µ) and resembles *I. zosteropis* Chakravarti and Kar[4] (17·6–22·2 × 13·2–19·8 µ) and *I. bengalensis* Mandal and Chakravarti[5] (18·7–23·3 µ). The latter has a micropyle. However, *I. gypsi* was distinct from them as it contained an oocystic residuum of significant size.

The authors are grateful to the Director of Animal Husbandry and Veterinary Services, Orissa, for the facilities afforded.

State Veterinary Laboratory,
Bhubaneswar-3,
February 18, 1969.

M. M. PATNAIK.
D. N. MOHANTY.

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DYNAMIC MODULI OF A FEW TERTIARY ROCKS*

EMPLOYING the pulse travel time technique,[1,2] ultrasonic wave velocities—both compressional (V_P) and shear (V_S) are determined in six tertiary rock types—migmatite, migmatitic and orbicular quartzite, shaly sandstone, augen gneiss and granite. The transducers used for compressional and shear modes are barium titanate (1″ dia., 1 Mc/s. fundamental freq.) and quartz AT cut (1″ dia., 5 Mc/s. fundamental freq.) plates respectively. The elastic moduli—'E', 'µ', 'K' and 'σ', calculated from the velocity data and densities 'ρ' along with the porosity

TABLE I

Wave velocities (km./sec.) and moduli (10″ dynes/cm.²)

Serial No.	Rock type	Location†	ρ gm./c c.	P %	V_P		V_S		E_S Young's modulus	μ Rigidity modulus	K Bulk modulus	σ Poisson's ratio
					(*a*)	(*b*)	(*a*)	(*b*)				
1	Migmatite ..	Dalhousie	2·48	11·5	1·49	2·69	..	..	..	..	..	..
2	Orbicular quartzite	Harayana	2·68	0·2	6·00	5·75	3·22	2·91	7·20	2·77	5·95	0·30
3	,, ..	,,	2·68	0·2	6·00	5·73	3·34	2·98	7·65	2·99	5·67	0·28
4	, ..	,,	2·71	0·2	5·92	5·67	3·22	2·89	6·79	2·61	5·52	0·30
5	Migmatitic quartzite	Dalhousie	2·68	0·4	4·10	3·63	2·45	1·98	4·09	1·61	3·05	0·27
6	,, ..	,,	2·68	0·4	4·20	3·31	2·41	2·06	3·91	1·55	2·67	0·26
7	, ..	,,	2·67	0·4	4·15	3·35	2·36	1·97	3·75	1·49	2·64	0·26
8	Shaly sandstone ..	Simla hills	2·62	3·0	3·54	4·17	1·81	2·17	2·27	0·86	2·14	0·32
9	Augen gneiss ..	Chor area	2·73	0·6	5·28	4·97	2·84	..	5·72	2·20	4·69	0·30
10	, ..	,,	2·74	0·6	5·40	5·35	2·97	..	6·17	2·39	4·80	0·29
11	,, ..	,,	2·75	0·6	5·36	4·89	2·89	..	6·01	2·31	4·84	0·30
12	Tertiary granite ..	Mandi	2·66	1·0	4·20	3·84	2·45	2·25	3·94	1·59	2·57	0·24

† The samples are provided by the Department of Geology, Punjab University.

values 'P' are reported in Table I. The observations in the long (*a*) and short (*b*) directions of the rock cylindrical specimens are also included. However the elastic moduli are computed from the velocity data of the longer direction.

It is observed that the rock types studied are highly absorptive and exhibit low velocity values. In the case of migmatite (medium-grained and grey-coloured) which is highly porous (11·5%), the V_p itself is found to be low with the result, shear wave propagation could not be studied in that. In the orbicular quartzite (fine-grained and buff-coloured) which is a compact and highly metamorphosed rock, the velocity values are found to be high. Migmatitic quartzite (compact, medium-grained and greyish-black in colour) is an intermediate case.

Shaly sandstone (very fine-grained and greyish-black in colour) and augen gneiss (black-coloured and fine-grained) fall in the intermediate category. The results in tertiary granite which is medium-grained, leucocratic, with the tourmaline crystals being visible are found to be lower than those of precambrian granites. This is in agreement with the results reported by Hayakawa and Balakrishna[3] on granites from different countries in which the reasons for the difference in velocities are attributed to the differences of the depth of original formation and the age. As expected the elastic wave velocities of the rock types studied are found to increase with the increase in density and decrease with the increase in porosity. In general it is observed that tertiary rocks show low velocity values.

We wish to express our thanks to Prof. I. C. Pande, Punjab University, Chandigarh, for providing the samples, and to Dr. S. Balakrishna for his guidance and encouragement, and to Dr. Hari Narain, Director, N.G.R.I., for permission to publish this note.

National Geophys. M. V. M. SATYANARAYANA RAO.
Res. Inst., B. VENKATANARAYANA.
Hyderabad-7 (A.P.),
March 31, 1969.

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CALANOPIA SEYMOURI SP. NOV. (COPEPODA : CALANOIDA) FROM THE ANDAMAN SEA*

IN the course of studies on the pelagic Copepoda of Andaman Sea an undescribed species of calanoid copepod of the genus *Calanopia* Dana was encountered in the plankton collections made from Nicobar waters. The description of the new species follows.

Calanopia seymouri SP. NOV. (FIG. 1, *a–j*)

Material.—Holotype CMFRI Reg. No. 113, Female, 2·62 mm., from surface plankton collected on 25–4–1968, 17·00–17·25 hours from Nancowrie Harbour, Nancowrie Islands; Allotype CMFRI Reg. No. 114, Male, 2·48 mm., from same sample as holotype; Paratypes CMFRI Reg. No. 115, 25 Males and 25 Females collected around Comorta and Champion Islands, Nicobars. The type specimens are deposited in the research collections of the Central Marine Fisheries Research Institute, Mandapam Camp.

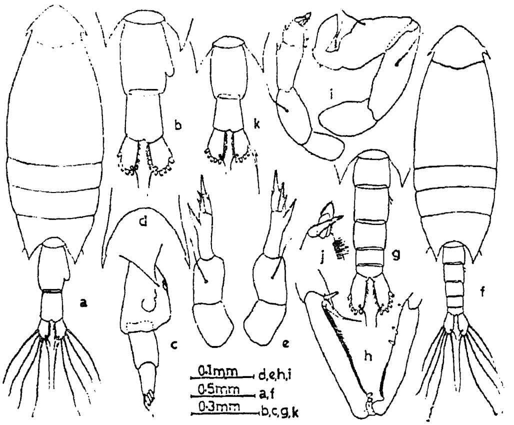

FIG. 1. *Calanopia seymouri* sp. nov. Female : *a*, dorsal view ; *b*, urosome, dorsal view ; *c*, urosome, lateral view ; *d*, rostrum ; *e*, P-5, Male ; *f*, dorsal view ; *g*, urosome, dorsal view ; *h*, right A-1, segments 18 and 19–21 enlarged ; *i*, P-5 ; *j*, terminal portion of left P-5 enlarged. *Calanopia australica* Bayly and Greenwood ; *k*, female urosome, dorsal view.

Description.—Female (Fig. 1, *a–e*): Length range 2·49 to 2·62 mm. ; prosome-urosome length ratio range 2·56–2·68 : 1 ; cephalosome distinct from T-I and with conspicuous lateral hooks ; rostrum deeply forked, each fork with a distal inner barb ; T-IV and T-V fused, latter produced posteriorly into asymmetrical points, right tip reaching middle of genital segment ; two-segmented urosome with caudal rami showing the ratio 50 : 29 : 21 = 100 ; genital segment asymmetrical with a hemispherical swelling on right lateral margin of segment at about posterior three-fourth of its length ; genital segment enlarges ventrally up to about its posterior margin, the condition being quite different from the protuberance found in *C. thompsoni* A. Scott[1] ; U-II longer than broad ; caudal rami asymmetrical, right one slightly broader than long and each ramus with five major setæ and one minute seta ; A-1 with 19 segments, when adpressed to the body reaches middle of genital segment ; Mx_2 and Mxp typical of the genus ; P-5 symmetrical with two-segmented basipods ; B_2 1·3 times as long as wide and with a seta ; exopods two-segmented, as long as the combined lengths of B_1 and B_2 ; Re-1 3·2 times as long as wide, produced at outer distal corner into sub-equal spine-like processes with serrated margin ; distal process closely adpressed to Re-2 and extending to about half its length (In *C. thompsoni* distal process of Re-1 is directed outwards as the proximal process of Re-1) ; Re-2 with two small outer marginal spines, a stout terminal prong with fine lateral marginal serrations and with one minute spine at inner distal corner.

Male (Fig. 1, *f–j*).—Length range 2·48 to 2·52 mm. ; prosome-urosome length ratio range 2·37–2·44 : 1 ; prosome resembles that of female ; five-segmented urosome with caudal rami showing the ratio 17 : 22 : 17 : 11 : 9 : 24 = 100 ; second urosomal segment longest and provided with two hair-like setæ on right ventrolateral margin ; anal segment short ; caudal rami symmetrical, length 2·5 times as long as broad ; right A-1 with segments 13-16 enlarged and imperfectly fused ; segment 18 with fine villiform marginal teeth ; fusion segments 19–21 with inner marginal villiform teeth on proximal part ; P-5 asymmetrical with three-segmented right leg ; terminal portion of the leg is movably attached to B_2 and consists of a swollen basal portion with two smoothly curved protuberances along inner edge, proximal one with a short seta at its inner base ; distal portion sharply recurved outwards swollen medially and tapering to pointed tip ; two sub-equal setæ are inserted near outer proximal edge of curve and one seta at the inner junction of basal and distal portions ; B_2 longest, 3·3 times as long as wide and with a seta ; left P-5 four-segmented with total length equal to combined lengths of B_1 and B_2 of right leg ; Re-1 twice length of Re-2 and with a spine at outer distal corner ; Re-2 provided with a spine along middle of outer margin and three sub-equal spines distally—the terminal one directed inwards and serrated laterally the second and third spines directed distad, former broad and stout ending in a conical prong, latter with blunt tip and marginal serrations ; a row of fine hairs present along inner margin of Re-2.

The new species is named after the late Dr. R. B. Seymour Sewell in honour of his pioneering works on the Copepoda of this region.

Remarks—Sewell[2] noted the differences dealt with above for the new species but he designated the specimens under *C. thompsoni*. Only three species of *Calanopia* have to date been described with cephalic hooks, *viz.*, *C. thompsoni*, *C. sewelli*[3] and *C. australica*.[4] *C. seymouri* will be the fourth species to be described under this group and in the characteristic modification of the genital segment and in the nature of the fifth leg it differs from the other known species.

Specimens of *C. australica* were also obtained from plankton tows off Comorta and Nancowrie Islands, thus extending the distribution of this recently described Australian species (from Moreton Bay, Queensland) to the Andaman Sea.

I wish to record my grateful thanks to Dr. S. Jones, Director, for the encouraging guidance; to Dr. E. G. Silas for critical suggestions and to C.S.I.R. for the award of a Fellowship.

Central Marine P. PARAMESWARAN PILLAI.‡
Fisheries Res. Inst.,
Mandapam Camp, *February* 12, 1969.

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‡ Present address: C.M.F.R. Sub-Station, T. D. Road, Ernakulam, Cochin-11.

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ON THE FUNCTIONAL IDENTIFICATION OF THE ADENOHYPOPHYSEAL CYANOPHIL CELLS IN THE GIANT GOURAMI, *COLISA FASCIATA* (BLOCH AND SCHNEIDER)

THE cyanophil cells of proximal pars distalis region of the teleostean hypophysis have been differentiated functionally into two cell types: Gonadotrophs and Thyrotrophs, by means of experimental treatment and application of specific staining methods.[1-7] Except for a very brief description of the morphology of the pituitary of the giant gourami,[8] no work on the histophysiology of its pituitary appears to have been done. A short description of the pituitary of *Colisa fasciata* is given here to explain the location of the cyanophils in its proximal pars distalis region. The pituitary is closely applied to the brain and is histologically distinguishable into the neurohypophysis and the adenohypophysis. The latter is divided into three lobes: rostral and proximal pars distalis, and pars intermedia arranged one behind the other from front to rear (Fig. 1). The rostral pars distalis is primarily acidophilic and chromophobic with few cyanophil cells. The proximal pars distalis contains brightly staining acidophils and cyanophils, and a few chromophobes. The pars intermedia is comprised of predominantly acidophils having large nuclei and finely granulated cytoplasm, few cyanophil and chromophobe cells.

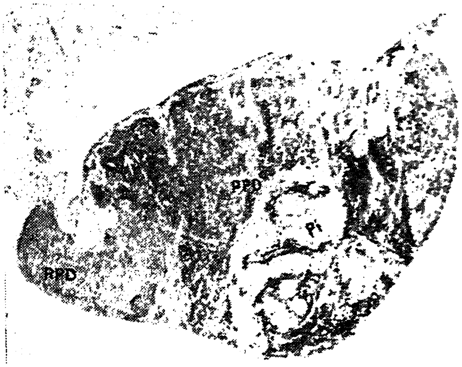

FIG. 1. Pituitary of *Colisa fasciata*. Bouin's fluid, CAHP, × 60. N = neurohypophysis, Pi = pars intermedia, PPD = proximal pars distalis, RPD = rostral pars distalis. Arrows show the position of cyanophils.

Of all the pituitary components in *Colisa*, the cyanophils of the proximal pars distalis exhibit profound correlative seasonal changes associated with the reproductive state of the fish. The cyanophils (Type 1) which lie interspersed with acidophils in the dorsal zone of the proximal pars distalis are variously shaped with round nucleus, conspicuous nucleolus and sparse chromatin material. These cells make their first appearance in the pre-spawning phase of the fish and with the advancement of the maturation of gonads, they show sign of activity. They are filled with darkly stained coarse secretory granules, and increase in size and number. During the spawning phase they are solidly packed with extreme dense granules and in some of the cells the secretory granules appear to have passed out into the neurohypophyseal branches surrounding the proximal pars distalis. These cells are brilliantly coloured with Aldehyde fuchsin (AF), Periodic acid-Schiff's (PAS) and Chrome-Alum-Hematoxylin-Phloxine (CAHP) stains, showing their glycoprotein or mucoprotein nature. They undergo active degranulation and vacuolization during the spawning phase and lose their contents during the post-spawning phase of the fish. Another type of Cyanophils (Type 2) are located in the ventral portion of the proximal pars distalis of the giant gourami, lying adjacent to the border of the pars intermedia. These cells are fusiform, elongated or oval in shape and smaller in size than the former in dorsal region. The cyanophils (Type 2) contain fine and closely packed granules and are less brilliantly stained with AF, PAS and CAHP. During the spawning phase these cyanophils show lesser degranulation and vacuolization than those distributed in the dorsal region of the proximal pars distalis.

Thus, with reference to changes in the physiological state of gonads and differential activity and staining clarity, it can be suggested that Cyanophil (Type 1) cells are Gonadotrophs (FSH-LH cells) and Type 2 cells, Thyrotrophs (TSH cells) in the pituitary of *Colisa fasciata*.

Department of Zoology, H. A. KHAN.*
Lucknow University,
Lucknow, *February* 10, 1969.

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* Present address: Central Inland Fisheries Research Institute, Barrackpore, West Bengal (India).

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RECORD OF *ANAGRUS* SP. A MYMARID (HYMENOPTERA) PARASITE ON EGGS OF *SOGATELLA FURCIFERA* HORVATH ON RICE IN INDIA

Sogatella furcifera Horvath commonly called the white-back plant hopper, assumed major pest status in paddy with the intensive cultivation of high yielding rice varieties and severe incidence of this delphacid was recorded during August and September 1966 and 1967 at the Central Rice Research Institute.[2] In the project for collection of natural enemies of rice pests, studies on egg parasites of *S. furcifera* were caried out.

The females of *S. furcifera* make an incision with the ovipositor in the lower epidermis of midribs of leaves and leaf-sheaths of rice plant and insert the eggs in masses with egg caps directed outside.[3] The exact sites of oviposition can be readily distinguished from other healthy portions of the plant as the former gradually turn from green to dark brown or black as eggs inside advance in age.

Rice leaves and leaf-sheaths containing eggs of *S. furcifera* periodically collected from field were cut into bits 8 to 10 cm. long and were kept inside paired glass Petri dishes. The inner surfaces of both Petri dishes were covered with fine blotting-paper. One end of all the cut pieces of leaves and leaf-sheaths were covered with a narrow cotton band. The blotting-paper and the cotton band were soaked with enough water before closing the lid in order to keep the plant parts from shrivelling or drying. The nymphs and parasites which emerged from eggs of *S. furcifera* were allowed to die inside the Petri dishes and were gently collected after floating them in water. The parasites that emerged were collected and sent for identification.

From egg-masses collected from the field during the end of September and first week of October, one species of Mymarid (Hymenoptera) parasite identified as *Anagrus* sp. emerged, which out-numbered the nymphs of *S. furcifera*.

Examination of leaves and leaf-sheaths after emergence of parasites showed the presence of very distinct, small and circular holes on them which corroborated the observations of Pagden[4] in Malaya that the Mymarid emerged through holes cut at the side of the midrib. This parasite appeared to be an important natural enemy limiting the multiplication of *S. furcifera* in the rice environment.

Anagrus sp. near *frequens* Perkins from Fiji and *A. optabilis* Perk. from Malaya have been reared from eggs of *S. furcifera*.[1] Two species *A. flaveolus* and *A. perforator* Perk. have been recorded as egg parasites of some leaf and plant hoppers other than *S. furcifera* from Japan.[7] Subbarao *et al.* (1965)[5] reared *Anagrus* sp. from the eggs of *Empoasca devastans* Dist. and described this species as new to science and Subbarao (1966)[6] described *A. empoascœ* Dozier reared from jassid eggs in Northern India, these being the only records of this genus in India. A review of published literature shows that this is the first record of *Anagrus* sp. as an egg parasite of *S. furcifera* on rice in India. Further studies of this species and its hosts might reveal a wider host range among rice leaf and plant hoppers.

The authors express their thanks to Dr. V. P. Rao, Entomologist-in-Charge, Indian Station of the Commonwealth Institute of Biological

Control, Bangalore, for arranging to get the parasite identified, and to Dr. S. Y. Padmanabhan, Director, for his keen interest and encouragement in this work.

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Cuttack-6, P. S. PRAKASA RAO.
February 3, 1969.

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REACTION OF GUNDHI BUG, *LEPTOCORISA VARICORNIS* FABRICIUS TO SOME FOOD PLANTS

GUNDHI bugs (*Leptocorisa varicornis* and *Leptocorisa acuta*) are the most important pests infesting paddy crop in the ear head stage in Madhya Pradesh, Uttar Pradesh, Assam, West Bengal and Bihar. This pest is known to cause 10 to 40% loss.

About 40 different species of plants have been reported as food or host plants of gundhi bugs. In paddy fields, gundhi bugs survive on some of the weeds till the paddy crop comes to flower when they migrate to the rice panicles. To our knowledge, no detailed study seems to have been done to find out whether these plants can support the different developmental stages of this insect so that they can be confirmed as alternate or collateral host plants. Therefore, studies were undertaken during 1968 at the Central Rice Research Institute, Cuttack, with just-hatched nymphs and adults of gundhi bug, *Leptocorisa varicornis* in order to establish the potentiality of some of the weeds commonly found in and around rice fields as host plants.

Reactions of Just-Hatched Nymphs.—Twenty just-hatched nymphs were caged in glass chimney on each of the following species of Gramineæ—*Paspalum scrobiculatum, Echinochloa crusgalli, E. colonum, Setaria glauca, Panicum proliferum, Panicum* sp. and Cyperaceæ—*Fimbristylis miliacea, Cyperus haspan.* The results showed that the just-hatched nymphs could develop further (15%) for a week on *Echinochloa colonum* whereas on the other plants tested they could not survive even for 24 hours under laboratory conditions. However, the observations in relation to *Echinochloa* were taken upto a week only.

Reactions of Adult Bugs.—In order to study the survival potential of adults, 10 freshly emerged adults were caged in wire-meshed cages on the following potted plants: *Paspalum scrobiculatum, E. colonum, Setaria glauca, E. crusgalli, Dichanthium annulatum, Panicum proliferum, Oryza sativa* (IR. 8) and *Fimbristylis miliacea, Cyperus haspan, Cyperus iria.* It was noted that 60% adult survival was obtained on *E. colonum* even after 40 days whereas on other plants they died within 10 days. On *Oryza sativa* the percentage survival recorded was 77·8 after 34 days.

These observations clearly show the greater specificity of adults and just-hatched nymphs of gundhi bugs towards *E. colonum* indicating that it is a potential alternate and collateral host. *E. colonum* is abundant in and around rice fields on which the bugs thrive till rice comes to flowering. Destruction of this weed (*Echinochloa colonum*) offers a great potentiality to counteract the outbreaks of this pest.

The authors are grateful to Dr. S. Y. Padmanabhan, Director, Central Rice Research Institute and Dr. A. B. Joshi, Deputy Director-General, Indian Council of Agricultural Research, for their keen interest and encouragement in these investigations.

Central Rice Res. Institute, M. B. KALODE.
Cuttack-6 (Orissa), C. P. YADAV.
February 3, 1969. P. ISRAEL.

EMS INDUCED "FINE GRAIN" MUTANT OF RICE (*ORYZA SATIVA* L.)

MUTATION breeding has now become an invaluable supplement in crop improvement through the breeding of new strains. Literature on chemical mutagenesis in rice (*Oryza sativa* L.) is rather meagre,[1-6] when compared to the enormous amount of work on irradiation studies. Investigations on chemical mutagenesis with a view to obtain high yielding agronomic varieties and to exploit new gene mutations in rice have been undertaken, using hybridization followed by induction of mutations.

A pure breeding hybrid TNI × MTU 3 at its F_5 generation was subjected to chemical mutagenesis with the potent alkylating mutagen, Ethyl Methane Sulphonate (EMS). Dry unhusked and husked seeds were soaked in 0·15%, 0·25%, 0·45%, 0·6% and 1·0% concentrations of EMS at three different pH levels, *viz.*, acidic (3·5 pH), neutral (7·5 pH) and alkaline (9·2 pH). For each treatment 100 seeds were used and the treatment period was 12 hours with constant shaking. After the treatment the seeds were thoroughly washed and sown immediately in the seedbeds and were later transplanted to the field.

A significant mutation was screened in the M_1 generation in the treatment of unhusked (rice) seed at 0·45% concentration of EMS at 3·5 pH. This was named 'Fine Grain Mutant' since the mutation markedly affected the grain shape and size besides affecting a few other characters. This mutation was obtained in a single plant in a population of 100 plants and the whole plant is of the mutant type, hence the mutation was not chimeral in nature (Fig. 1 *b*). The meiosis in the mutant plant was normal without any detectable chromosomal aberrations and the mutant bred true in M_2 generation. Mutations of similar kind 'long narrow grain' was earlier reported from X-ray irradiated rice of the variety Geb-24. by Ramiah and Parthasarathy.[7,8]

Mutation has also affected the height and duration of the crop and kernel transparency besides the grain size. The mutant plant is short in stature, high tillering, responsive to high manurial doses, with dark green leaves, the green shoots persisting upto the harvest time (Table I). Seed setting was normal with no sterility, but the duration of the crop was prolonged by 20 days more than the parent material. The grain is long and is narrow, the length by breadth (L/B ratio) being 0·46 (Table I). This is markedly deviating from the hybrid in that the grain is fine. The nature of the grain is also affected making the opaque endosperm into a transparent one.

TABLE I

Characters of the parent material (TNI × MTU 3 hybrid) and the EMS induced Fine Grain Mutant

Characters	TNI × MTU 3 hybrid	EMS induced fine grain mutant
1. Height of the plant ..	95 cm.	85 cm.
2. No. of tillers per plant ..	9–12	11–13
3. Leaf ..	Pale green to dark green	Dark green
4. No. of spikelets per panicle	185	182
5. Duration of crop ..	100 days	120 days
6. Susceptibility to bacterial blight	Susceptible	Free from bacterial blight
7. Length/breadth ratio of spikelets	0·39	0·46
8. Size of the grain ..	Medium	Fine
9. Nature of the grain ..	Opaque	Transparent

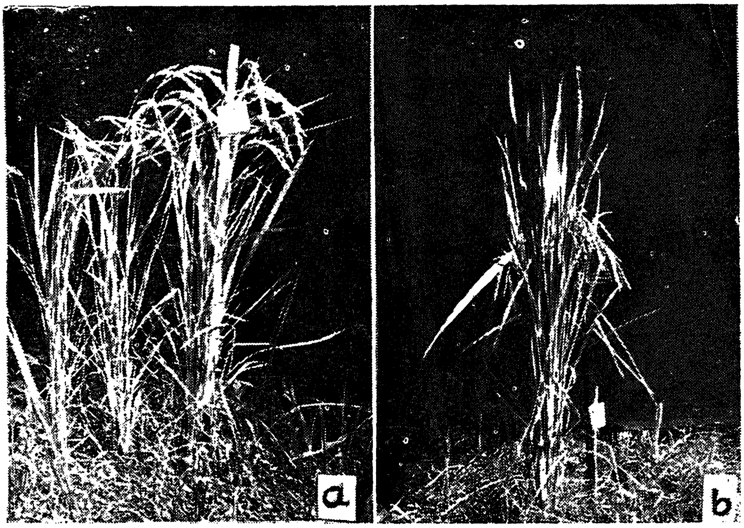

FIG. 1. Photographs of the parent material (TNI × MTU 3 hybrid) (*a*) and the EMS induced Fine Grain Mutant (*b*).

In the M_2 generation the progeny plants of the mutant were observed to be free from bacterial blight. A large population was grown at Ragolu (A.P.) Rice Experimental Farm, in the *kharif* season of 1968 along with other hybrid progenies from the same TNI × MTU 3 cross and also TNI. All of them were heavily infected by bacterial blight and the plot in which the fine grain mutant was grown, was not affected proving that this mutant is perhaps resistant to this disease. However, artificial inoculations for testing resistance to bacterial blight have to be made.

The mutation is a stable one, affecting the grain shape, size and nature.

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Dept. of Botany, J. V. PANTULU.
Andhra University, A. V. S. S. SAMBAMURTY.
Waltair, *January*, 13, 1969.

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NON-DISJUNCTION IN COLCHICINE-INDUCED AUTOTETRAPLOID *BRASSICA CAMPESTRIS*

THE phenomenon of non-disjunction of sex-chromosomes at meiosis first observed in *Drosophila* was later found to be widespread in human beings. Non-disjunction of homologous chomosomes may also occur with autosomes giving rise to hyperploids and hypoploids. Such unbalanced chromosomal variations disturb embryonic development much more severely than balanced changes such as polyploids.

Colchicine which is used therapeutically as a specific for gout is found to cause non-disjunction at meiosis. Although it is one of the earliest specific remedies found in pharmacopœia not much thought was given to its genetic effects. Recently, its mutagenic effect was demonstrated by several workers.[4-6, 9] High concentration of colchicine increased the mutagenicity of X-rays in seeds in addition to inducing some previously unknown mutations.[3] It was also found to reduce the frequency of chromosomal rearrangements.[2, 7] Reduction of diploid nuclei to haploid in *Aspergillus nidulans* is attributed to non-disjunction.[8] The mechanism by which somatic reduction occurs in *Sorghum* is said to consist of either a series of divisions involving non-disjunction and selection or genome segregation.[10]

In one of the colchicine-induced autotetraploids of *Brassica campestris* ($2n = 40$) a quadrivalent, which had failed to segregate, was observed in the second metaphase (Fig. 1).

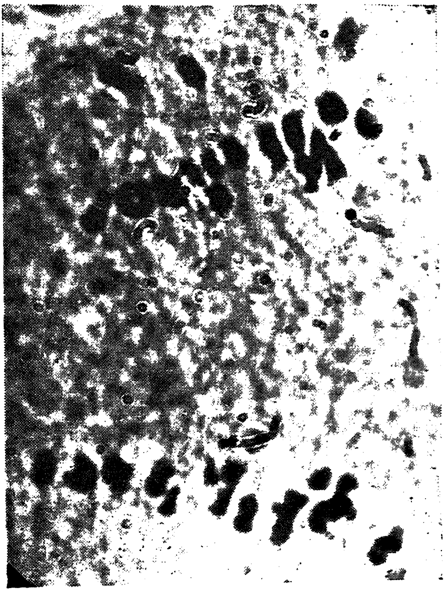

FIG. 1. Second metaphase in autotetraploid *Brassica campestris* showing a ring quadrivalent and unequal (22 : 18) segregation of chromosomes.

Obviously the four homologous chromosomes which had paired and formed a ring quadrivalent failed to separate at first anaphase and gave rise to two groups, one containing 22 and the other 18 chromosomes. If they had produced functional cells hyperploids and hypoploids would have resulted by fertilization with the normal diploid. But this was not the case with the present material. However, in the progeny of the tetraploid which showed non-disjunction of a quadrivalent, a diploid plant with $2n = 20$ chromosomes was found.[11] Its meiotic studies revealed a quadrivalent at first metaphase giving unequivocal evidence for the origin of the diploid from the tetraploid. The 44-chromosome cell resulting from non-disjunction of a quadrivalent seems to have segregated into 20 and 24 chromosome groups again as a result of non-disjunction of a quadrivalent and the 20-chromosome euploid cell became functional in spite of one of its chromosomes being quadruple.

The centromere exercises control over pairing and delays it in its immediate neighbourhood. Colchicine which has a specific effect on the centromere destroys this control mechanism and allows the chromosomes to come together at any point, often in two or three places, at once leading to a scramble which results in an extraordinary amount of interlocking.[1] The presence of the quadrivalent in metaphase II in the present material may be due to this type of interlocking which has delayed separation.

Division of Genetics, D. SRINIVASACHAR.
Indian Agri. Res. Inst.,
New Delhi, *February* 8, 1969.

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A NEW FOSSILIFEROUS LOCALITY OF THE DECCAN INTERTRAPPEAN BEDS, IN CHHINDWARA DISTRICT, M.P.

THE earliest collections of fossil plants from Chhindwara District, M.P., were made by Hislop and Hunter (1854)[1] and Hislop (1861–69).[2] They collected numerous petrified plants from these sedimentary beds along with faunal remains. Mohgaon Kalan, a village in Chhindwara District (M.P.), where Deccan Intertrappean beds are exposed, was discovered by Prof. K. P. Rode.[3] This fossiliferous locality has since become classic and numerous contributions on the plants occurring there have been made.[4-6]

While collecting fossil plants from Mohgaon Kalan and adjoining areas, we came across a new, richly fossiliferous locality of the Deccan Intertrappean beds. This locality is about 2 miles east of Markahandi Railway Station (22° 3′; 79° 13′).

The fossils occur scattered at the base of a small hillock. The fossiliferous cherts bear a striking resemblance with those occurring near Mohgaon Kalan. Stems, inflorescence axes, leaves, possibly fruit, invertebrates and other fragmentary remains have been collected. We also collected a few large palm stems. The fossil plants in general appear to be well preserved.

Department of Botany, B. S. TRIVEDI.
Lucknow University, C. L. VERMA.
Lucknow, *February* 6, 1969.

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REVIEWS AND NOTICES OF BOOKS

Chemistry and Physics of Carbon (Vol. 4). Edited by Philip L. Walker, Jr. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xii + 399. Price $ 20.75.

Following the objectives of this monograph series as outlined in Volume 1, Volume 4 of the *Chemistry and Physics* of Carbon series under review is concerned with recent advances in carbon research and development and with comprehensive reviews of past achievements in important areas of carbon. Among the topics covered in this volume are X-ray diffraction studies of the many forms of carbon, experimental and theoretical approaches to the problem of vaporization behaviour of carbon and graphite at high temperatures, and the mechanical properties of graphite. The growing of relatively large crystals of graphite with controlled defect concentration, the conversion of organic compounds and complex mixtures to chars and cokes, and the catalysis of the gasification of carbon by oxidizing gases are also discussed.

The interdisciplinary approach of the series is evidenced by the fact that the authors of this volume, as of the other volumes, include organic chemists, physical chemists, solid-state physicists, electrochemists, chemical engineers, and materials scientists, each an expert of international repute in his respective field.

C. V. R.

Phosphoric Acid (*Fertilizer Science and Technology Series*), Volume 1, Part II. Edited by A. V. Slack. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y.), 1968. Pp. xvii + 1159. Price $ 42.50.

Fertilizer production has developed into one of today's major chemical technologies and an area of critical importance in our rapidly developing world. *The Fertilizer Science and Technology Series* has been designed to provide, in separate volumes, comprehensive coverage of the major segments of the industry, making available a reference library to which any worker in the field may turn for needed information.

Phosphoric acid is one of the major raw materials in fertilizer production, and discussion of it logically precedes treatment of fertilizer end products. Volume I (in two parts) of the series covers all phases of phosphoric acid chemistry and technology, from the basic chemistry of raw materials and processes to engineering problems and operating difficulties.

Part II discusses in detail the electric furnace method, the use of hydrochloric or nitric acid rather sulphuric acid for phosphate rock dissolution in the wet process, and the chemistry and production of polyphosphoric acids, as well as concentration, purification, corrosion, handling, and waste disposal.

All those concerned with the chemical and fertilizer industries, including chemists, engineers, agronomists, economists, and technicians, will find this treatment of phosphoric acid highly useful.

The titles of the chapters contained in Volume I, Part II are: Disposal or Use of Gypsum; Concentration of Wet-Process Acid; Purification of Wet-Process Acid; Handling and Treatment of Plant Effluents; Corrosion and Materials of Construction; Use of Acid Other than Sulphuric Acid; Phosphoric Acid by the Furnace Process; Polyphosphoric Acid; and Handling and Shipping Phosphoric Acid.

C. V. R.

Plant Cells—*Botanical Monographs* (Vol. 8). By F. A. L. Clowes and B. E. Juniper. (Blackwell Scientific Publications, Oxford and Edinburgh), 1968. Pp. xvii + 546. Price £ 6.

This book under review gives a detailed account of the structure of plant cells, especially those that have been discovered within the last ten years with the aid of electron microscopy, autoradiography, and cytochemistry. It deals with physiology and structure from the point of view of the development of cells and their components from the meristematic state to maturity, with cell cycles and cell heredity. The information is throughout related to the functioning of plants. Although the book primarily concerns plant cells, similarities and differences between them and animal cells are stressed so that it will be useful to all biologists.

The contents of this volume are: 1. Techniques in Cell Research; 2. Dimensions; 3. Cytoplasm: Physical Properties, Membranes, Ribosomes and Tubules; 4. Cytoplasmic Organelles; 5. Walls and Surfaces; 6. Nuclei;

7. The Cell Cycle ; 8. Differentiation ; 9. Specialised Cells ; and 10. Cell Heredity.

C. V. R.

Annual Review of Entomology (Vol. 19). Edited by Ray F. Smith and Thomas E. Mittler. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, U.S.A.), 1969. Pp. 478. Price : U.S.A. $ 8.50 and Other Countries $ 9.00.

Volume 19 of this well-known series contains the following articles : Baron Osten Sacken and His Influence on American Dipterology, by Carles P. Alexander ; Philosophical Aspects of Taxonomy, by Alexander A. Lubischew ; Effects of the Pleistocene on North American Insects, by Henry F. Howden ; Alarm Pheromones, by Murray S. Blum ; Induced Sterilization and Control of Insects, by M. D. Proverbs ; Bionomics and Physiology of Aphidophagous Syrphidæ, by Fritz Schneider ; The Ecology of Tetranychid Mites and Their Natural Control, by C. B. Huffaker, M. van de Vrie, and J. A. McMurtry ; The Development and Use of Life Tables in the Study of Natural Insect Populations, by D. G. Harcourt ; The Ecology of *Myzus persicæ*, by H. F. van Emden, V. F. Eastop, R. D. Hughes, and M. J. Way ; The Swarming and Mating Flight of Diptera, by J. A. Downes ; Comparative Social Behavior of Bees, by Charles D. Michener ; Respiratory Systems of Insect Egg Shells, by H. E. Hinton ; Systemic Pesticides for Use on Animals, by M. A. Khan ; The Cholinergic System in Insect Development, by B. N. Smallman and A. Mansingh ; and Mechanism of Selective Insecticidal Action, by F. P. W. Winteringham.

C. V. R.

Fluorine Chemistry Reviews—Vol. 2. (Book Edition). Edited by Paul Tarrant. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1968. Pp. 184.

This book edition of Fluorine Chemistry Review for 1968 contains five review articles. In the first article on the Cycloaddition Reaction of Fluoroolefins, W. H. Sharkey indicates most recent developments in fluoroolefin cycloaddition and discusses the variety of fluorine-containing, four-membered ring compounds that have been made accessible through cycloaddition. In the second article, The Reaction of Halogenated Cycloalkenes with Nucleophiles, J. D. Park, R. J. McMurtry and J. H. Adams review the extensively studied class of nucleophiles, the alkoxide ion, and also examine other nucleophilic species like sulphur-containing, nitrogen-containing, carbon as nucleophile and metal hydrides as nucleophiles. The third article is by J. W. Hastie and J. L. Margrave on Ionization Potentials and Molecule-Ion Dissociation Energies for Diatomic Metal Halides. In the paper on NMR Spectra of Nitrogen-Fluorine Compounds, W. S. Brey, Jr. and J. B. Hynes have compiled and attempted to correlate much of the published (and also unpublished) data on the NMR parameters of fluorine atoms attached to nitrogen. The last article is on ^{19}F Chemical Shifts and Coupling Constants of Fluoroxy Compounds by C. J. Hoffman.

A. S. G.

Books Received

Annual Review of Nuclear Science (Vol. 18). Edited by E. Segre, J. R. Grover and H. P. Noyes. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, Calif., U.S.A.), 1968. Pp. v + 553. Price : $ 8.50 in U.S.A., $ 9.00 elsewhere:

Introduction to Modern Algebraic Concepts. By Max D. Larsen. (Addison Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1), 1967. Pp. 143. Price 46 *sh.*

Botanical Monographs (Vol. 8). *Plant Cells.* By F. A. L. Clowers and B. E. Juniper. (Blackwell Scientific Pub., 5, Alfred St., Oxford), 1968. Pp. xi + 546. Price £ 6.

The Genetics of Bacteria and Their Viruses—Studies in Basic Genetics and Molecular Biology (2nd Edn.). By William Hayes. (Blackwell Scientific Pub., 5, Alfred St., Oxford), 1968. Pp. xvi + 925. Price 95 *sh.*

Principles of Modern Heterocyclic Chemistry. By Leo A. Paquette. (W. A. Benjamin, Inc., 2, Park Avenue, New York 10016), 1968. Pp. xiv + 401. Price $ 11.95.

Autoxidation of Hydrocarbons and Polyolefins Kinetics and Mechanisms. By Leo Reich and S. S. Stivala. (Blackwell Scientific Pub., 5, Alfred Street, Oxford, England), 1969. Pp. xi + 527. Price $ 29.75.

Physical Chemistry. By F. Daniels and R. A. Alberty. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1969. Pp. vii + 671. Price Rs. 18·00.

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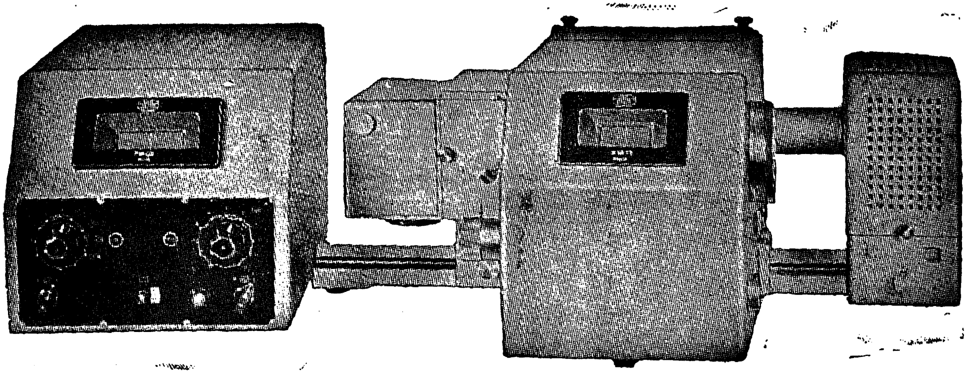

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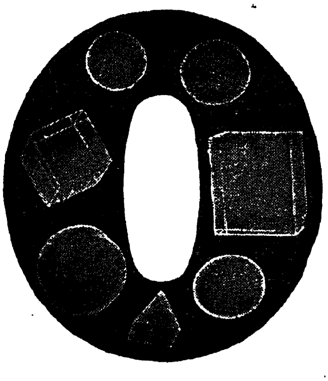

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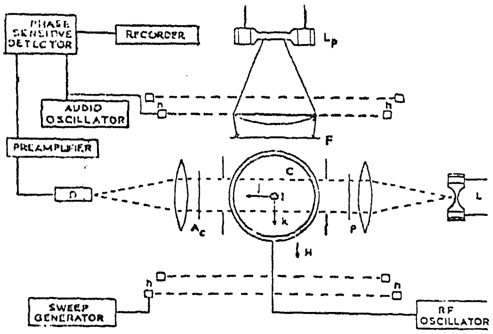
MODULATED BIREFRINGENCE*

S. PANCHARATNAM

THE subject of my paper is closely connected with that in the papers presented earlier by the scientists from the Soviet Union and from Italy. But they were concerned mainly with circular birefringence and circular dichroism shown by a medium which has acquired a net magnetisation due to spin-orientation. Whereas, I shall be dealing also with ordinary linear birefringence which can occur even when there is no net magnetisation—provided there is an alignment of spins parallel or antiparallel to some axis.



D.C BIREFRINGENCE SIGNALS (J.Phys.B,1968,1,250)

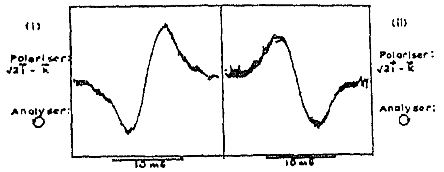


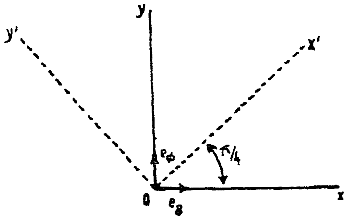
FIG. 1

Figure 1 gives an idea of the apparatus for observing *d.c.* or time-averaged birefringence signals. The sample here consists of He^4 atoms in the metastable state 2^3S_1. It is optically pumped with unpolarised 1μ resonance radiation so that the spins are *aligned* rather than oriented in line with the *k*-axis. The alignment makes the medium optically uniaxial. And this is detected in a transverse beam, linearly polarised. A monitoring lamp providing off-resonant radiation and a circular analyser are also essential. These traces show in effect a plot of the derivative of the intensity received by the photodetector D as a function of a magnetic field applied along *k*. Near magnetic resonance, transitions between Zeeman levels are induced because of the radio-frequency field; this disaligns the spin-assembly, reduces the birefringence and gives rise to these signals.

For other important features of the d.c. birefringence I can only refer you to the original paper. In that paper I had commented only briefly on the fact that the radio-frequency field does not only produce transitions. The expression for the polarisability, derived by Series, on which this work is based, shows oscillatory terms, reflecting the coherence between Zeeman levels. Thus in addition to d.c. birefringence, we should also have *modulated birefringence* about which I shall speak.

OPTICAL THEORY

RESOLUTION OF INSTANTANEOUS BIREFRINGENCE INTO COMPONENTS (WITH FIXED AXES)



DIRECTION OF PROPAGATION $\hat{e}_r$, NORMAL TO PAPER

COMPLEX LINEAR BIREFRINGENCE, AXES Ox Oy : $2\pi\,\delta\alpha_1$

COMPLEX „ „ „ , AXES Ox' Oy' : $2\pi\,\delta\alpha_2$

COMPLEX CIRCULAR BIREFRINGENCE : $2\pi\,\delta\alpha_3$

SPHERICAL TENSOR COMPONENTS $\alpha(k,q) = \langle \alpha_{op}(k,q) \rangle$

FIG. 2

A fairly comprehensive theory for the optical monitoring of optical pumping signals has been developed for this purpose and I can only touch on some points. Our approach, in contrast to that in Cohen-Tannoudji's recent work, is to solve Maxwell's equations for light propagation in an anisotropic medium. We consider an arbitrary direction of propagation which we take to be normal to the plane of the screen. The principal planes of linear birefringence may be changing in time, and instead of following them around we resolve the linear birefringence into two components with respect to fixed axes: First is the linear birefringence with respect to axes Ox Oy as principal planes, and second that with principal axes Ox′ Oy′ turned by 45° with respect to the first. Lastly, we have of course complex circular birefringence. These anisotropy parameters can be quite simply related to the expectation values of polarisability operators as in Happer's work, but I shall not go into this. The question is what property of the spin-assembly do the real parts of the birefringence parameters measure, and what effect do they have on the polarisation of the incident beam?

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* This paper reproduces the text of a lecture by the late Dr. S. Pancharatnam to a Conference at Warsaw in June 1968.

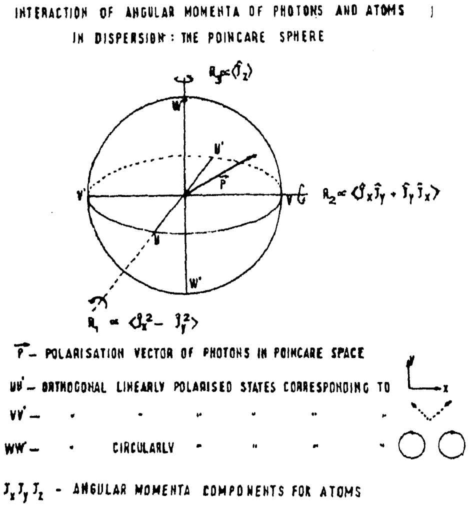
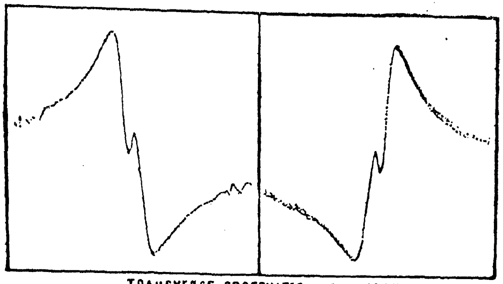

INTERACTION OF ANGULAR MOMENTA OF PHOTONS AND ATOMS
IN DISPERSION: THE POINCARE SPHERE
$R_3 \propto \langle \hat{J}_z \rangle$
W
U′
$\vec{P}$
V′
V
$R_2 \propto \langle \hat{J}_x \hat{J}_y + \hat{J}_y \hat{J}_x \rangle$
U
W′
$R_1 \propto \langle \hat{J}_x^2 - \hat{J}_y^2 \rangle$
$\vec{P}$ – POLARISATION VECTOR OF PHOTONS IN POINCARE SPACE
UU′ – ORTHOGONAL LINEARLY POLARISED STATES CORRESPONDING TO
y
x
VV′ – " " " " " "
WW′ – " CIRCULARLY " " " "
$J_x J_y J_z$ – ANGULAR MOMENTA COMPONENTS FOR ATOMS

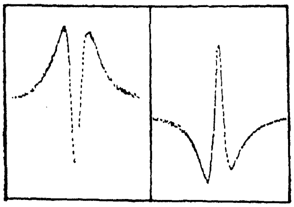
FIG. 3

Figure 3 illustrates the answer to this question which really concerns the interaction of the angular momenta of photons and atoms in dispersion. We use Poincare's representation of the state of polarisation of light by a point on the surface of a unit sphere. Alternatively, if we join the origin to the representative point, the radius vector $\vec{P}$ represents the polarisation vector of the incident photon in Poincare space. This Poincare representation is very closely related to both the classical and quantum mechanical description of light by Stokes parameters, as has been emphasised by Fano. Orthogonally polarised states are represented by opposite points on the Poincare sphere. Thus, the points U and U′ on the equator represent, as indicated in Fig. 3, the orthogonal linearly polarised states Ox Oy. The points V and V′ represent orthogonal linearly polarised states turned by 45° to the first set as drawn here. Lastly, the poles WW′ represent left and right circular polarised states. These are precisely the three pairs of states with respect to which we had resolved the birefringence in the previous figure. The subject of angular momenta in quantum mechanics is intimately connected with rotations. So it is particularly satisfying to note that the effect of the 3 real types of birefringence is to induce respectively proportional rotations R_1, R_2 and R_3 about these mutually orthogonal axes. What about the magnitudes of these rotations? Let J_x, J_y, J_z be the components of the spin angular momentum of the atomic assembly along Ox, Oy, Oz in real space. Then the rotation R_3 about the polar axis, which represents circular birefringence, is proportional to the expectation value of $(\hat{J}_z)$. The rotation R_1 representing the real x, y birefringence is proportional to the expectation value of $(\hat{J}_x^2 - \hat{J}_y^2)$; while the rotating R_2 representing the 45° birefringence is proportional to the correlation between the x and y components of the angular momentum. It should be noted that even when the average values of the angular momentum components vanish—that is when we have no orientation, these two average values which are quadratic in the components may not vanish—that is when we have alignment. In fact, it is convenient to express these two in terms of the five alignment components, which are the second rank multipole components of the density matrix.

Under magnetic resonance conditions, these expectation values contain not only d.c. components but also oscillatory components; for example, Manuel and Cohen-Tannoudji have monitored the oscillation of J_3 averaged. We know that Bloch's equations, which may be regarded as equations of motion for the orientation components, determine the time-dependence and resonance functions for J_3. In exactly the same spirit we have derived separate equations of motion for the alignment components alone, under magnetic resonance; these are solved assuming that some mechanism pumps one of the components, *viz.*, that with ordinal number zero. Also 3 phenomenological relaxation times are introduced. The equations of motions and the resonance functions for alignment apply to spin-systems of any angular momentum J, just as Bloch's equations apply to any J. When we set the 3 relaxation times equal, the resonance functions reduce to the functions A to E first derived by Series.



TRANSVERSE OBSERVATION, 1 ω = 10 kHz



LONGITUDINAL OBSERVATION, 2 ω = 20 kHz

MODULATED BIREFRINGENCE SIGNALS

FIG. 4

Figure 5 illustrates examples of modulated birefringence signals in magnetic resonance. The experimental set-up using He^4 is basically similar to that in the first figure. But now we look at *a.c.* signals, phase locked to a rotating transverse field, and use different combinations of polariser and analyser. Here we have in transverse observation, essentially the function B of Series, arising from the 45° birefringence which is modulated at the fundamental frequency. Here we have in longitudinal observation essentially the resonance function D of Series in a birefringence signal modulated at twice the frequency of the rotating field.

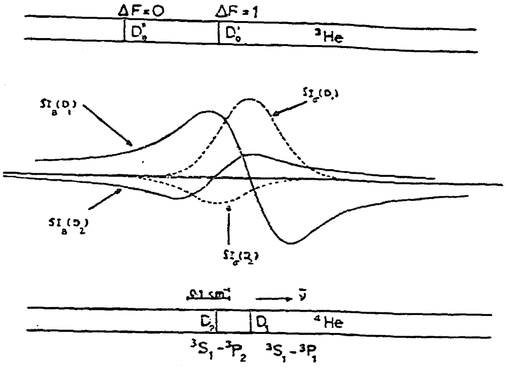


FIG. 5

Note by the Editor: Dr. S. Pancharatnam whose lecture at Warsaw is being published in this issue of *Current Science* was a Fellow of St. Catherine's College at Oxford at the time of his death on the 28th May 1969, when he was only 35 years of age. Pancharatnam went to Oxford in 1964 to work at the Clarendon Laboratory. During his last five years, his main interest was on the interaction of photons and atoms, optical pumping and related experiments, to which subject he made significant contributions. During the last few months of his life, he wrote extensively on many new theoretical ideas he had developed on the subject. These manuscripts are being sorted out and it is hoped that they will, in due course, find publication.

Dr. Pancharatnam started his research career at the Raman Research Institute, Bangalore, where his early investigations on the optical phenomena of crystals led him to develop his fundamental work on the generalized theory of interference and the description of partial polarisation and partial coherence. Immediately prior to his move to Oxford, he was for two years at the University of Mysore as a Reader in Physics, where he took a major part in the organisation of the Physics Department.

A RAPID DYE-BINDING METHOD OF SCREENING SINGLE GRAINS FOR PROTEIN CHARACTERISTICS

A. K. KAUL, R. D. DHAR AND M. S. SWAMINATHAN
Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi-12, India
AND
GUNNAR AHNSTRÖM
Institute of Radiobiology, University of Stockholm, Odengaton 63, Stockholm, Sweden

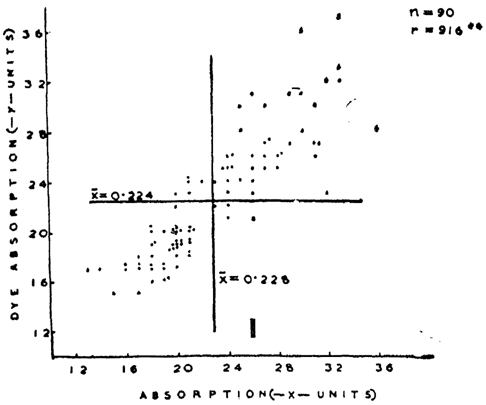
FOLLOWING the demonstration of Mertz, Bates and Nelson[1] that genetic manipulation of amino-acid balance is possible in maize, there has been much interest among geneticists and plant breeders in exploring the possibilities for upgrading the protein quality of the major food crops. This approach is of particular significance to fighting protein malnutrition in the developing countries since no special educational effort would be needed for improving nutrition if the basic staple has superior protein quality.[2] An important requisite for isolating genotypes with superior protein properties and for making rapid selection advance in segregating populations is the availability of rapid, reliable and non-destructive methods of assessing protein quality. Techniques involving the measurement of dye-binding capacity (DBC) have been reported to provide an estimate of the content of crude proteins,[3-5] basic amino-acids and lysine[7,8] in cereals. In a programme in our laboratory designed to identify genotypes in rice (*Oryza sativa* L.) with more protein and an altered pattern of distribution of proteins (usually, protein is concentrated in the aleurone and subaleurone layers of the rice kernel), we developed a micro-DBC method which is useful for estimating protein quality in single grains, without damaging the embryos. Though developed for rice, this technique was later found to give equally reliable results in *Zea mays*, *Triticum æstivum*, *Phaseolus aureus*, *Cajanus cajan*, *Sorghum vulgare* and *Pennisetum typhoides*. The technique, described below, may hence be of wide interest.

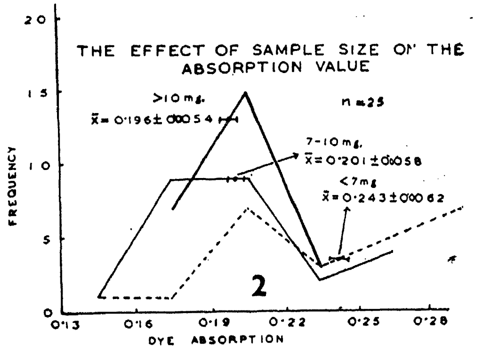
The germ, along with a small portion of endosperm, was cut and preserved in a refrigerator for raising seedlings later, if desired. The rest of the seed was gently crushed in a small mortar. A 12 ± 0·5 mg. crushed sample was placed in a plastic mixing vial (3·0 × 0·5 cm. of 0·65 ml. capacity) and two glass beads were introduced into it. The sample was further reduced to a fine powder by vigorously shaking the stoppered tubes on a dentist's amalgamator (Wig-L-bug) for one minute. A 0·50 ml. dye solution (Acilane orange G 'Bayer' 2·000 g., Citric acid 15·8400 g., Disodium-hydrogen phosphate 2·980 g. and Thymol 0·300 g./litre)[9] was introduced into the vial and it was again mixed for two minutes on the amalgamator. Five vials could be mixed successfully at a time. The tubes were centrifuged in lots of sixty-four at 3,500 r.p.m. The unabsorbed dye was diluted 200 times before reading the absorption at 470 mμ. Dilution could be avoided by using a special calorimeter having a short light path cuvette.[10] The absorbed dye was then computed by subtracting the absorption figures from the standard value (each new batch of dye was calibrated to 0·42 absorption units at 470 mμ) and further adjusted to express it uniformly on a 10 mg. sample basis. The bound dye could be best expressed as mM/g. of sample but for purposes of preliminary screening the absorption values as such were found to be quite satisfactory.

The reproducibility of the technique is remarkable provided the samples are stored under controlled conditions.[11,12] The duplicate analyses of one hundred seeds gave identical results. However, when transverse halves of the same grain were analysed separately, the differences detected between the halves were highly significant indicating the existence of intra-grain variation for protein (Fig. 1).

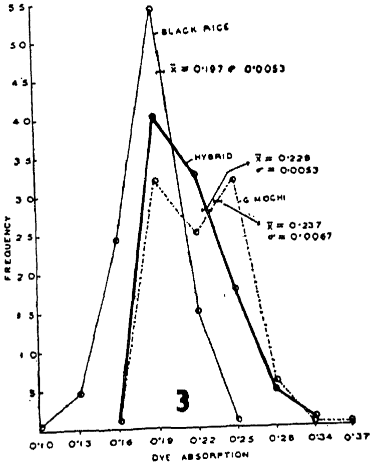
The effect of sample size was studied by analysing, in duplicate, twenty-five samples each of 7 mg., 7–10 mg. and 10–12 mg. weight from the same lot of seed. The results, summarised in Fig. 2 indicated that samples of 10–12 mg. class showed the least variation. The mean absorption value of this class (0·196 ± 0·054) tallied closely with the mean of the large population (black rice in Fig. 3). However, in the case of protein-rich grains, *e.g.*, pulses, the sample size should not exceed 5 mg. The correspondence noted between the micro- and macro-DBC method is indicated in Table I.

CORRESPONDENCE BETWEEN PROTEIN DYE ABSORPTION VALUES OF TWO HALVES FROM THE SAME GRAIN





FREQUENCY DISTRIBUTION OF 100 SEEDS EACH OF TWO RICE PARENTS, AND THEIR HYBRID, FOR DYE ABSORPTION.



FIGS. 1-3. Depicting the intar-grain variation for DBC. the effect of sample size and frequency distribution of DBC values in a cross between two rice strains, respectively.

TABLE I

Comparison of different methods of estimating the protein quality in 5 varieties of rice

Variety	Protein Content			Lysine g./16 gm. N	DBC absorption value	
	N × 6·25	On 500 mg. DBC basis	On 10 mg. DBC basis		On 10 mg. sample	On 500 mg. sample
1	8·5	8·6	8·1	3·35	0·18	0·19
2	10·0	10·4	9·7	4·00	0·21	0·22
3	9·2	9·2	9·2	3·89	0·20	0·20
4	8·6	8·1	7·5	3·01	0·17	0·18
5	9·8	9·2	9·2	3·73	0·20	0·20
Mean	9·25	9·10	8·74	3·596	0·192	0·198

The method was used successfully to study the protein quality of a large number of primitive cultivars of *Oryza sativa*. For example, where two parents and their hybrid were studied, the genetic differences in protein quality could be detected successfully (Fig. 3). Thus, this technique may be of value in both breeding and genetic experiments. DBC values and lysine content show a high positive correlation[13] and hence the technique may be of value in a preliminary screening for lysine content. This would help in restricting the number of samples that may be subjected to detailed lysine and amino-acid analysis using the standard methods.

We are indebted to Miss M. Sharma for technical assistance and to Dr. G. B. Baird and the Rockefeller Foundation for providing some of the chemicals and equipment used in this study.

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FALLOUT RADIOACTIVITY IN THREE BRACKISH WATER MOLLUSCS FROM KERALA*

K. V. K. NAIR, (THE LATE) Y. M. BHATT AND G. R. DOSHI
Health Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-85

THE spread of radioactive fallout from nuclear weapon testing and from release of radioactive waste from shore-based atomic installations has led to a world-wide search for indicator organisms. This is based on the known ability of some organisms to concentrate specific chemical elements by very high orders of magnitude. Molluscs in general assume special significance in this connection since many of them concentrate elements such as manganese and zinc to significantly high levels.[1-3]

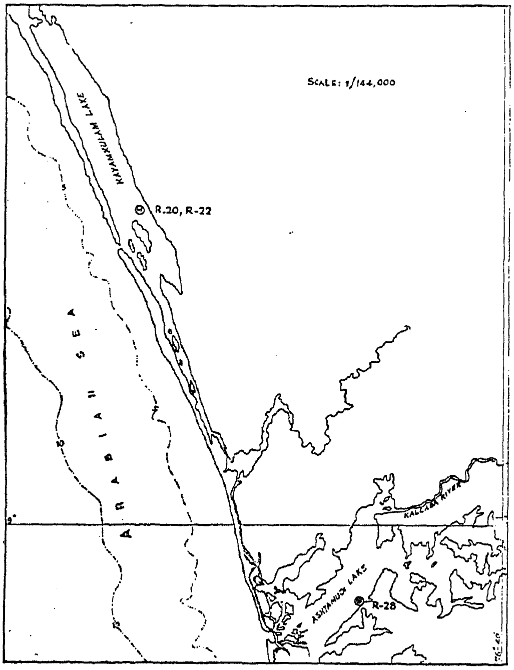

FIG. 1. Location of sampling sites.

The chain of backwaters running parallel to the Kerala Coast (Fig. 1) is inhabited by several species of molluscs many of which are eaten by the local population. In the present investigation three species of molluscs, *viz.*, *Ostrea madrasensis*—the common backwater oyster from Ashtamudi lake, *Villorita cochinensis*—a backwater clam and *Pila globosa*—a freshwater snail from the Kayamkulam lake have been chosen for radioactivity determination, and stable element analyses. Ashtamudi and Kayamkulam are brackish water lakes, the former connected to the sea throughout the year and the latter for about 8 months in a year (for about 4 months between January and May the bar-mouth is closed).

Methods.—Samples of the three species mentioned above were collected during the period, January-February 1964. After washing free of extraneous matter and removing the shells, the soft parts were dried to constant weight at 100° C. and ashed in a muffle furnace at 400° C.

About 10 g. of the ash was filled in a 1" diameter polythene tube and counted in a gamma-spectrometer using a NaI (Tl) well crystal as the detector. The samples were recounted after a time lapse to follow the radioactive decay and confirm the identification of radionuclides. The quantities of individual radionuclides in the three samples were determined by spectrum stripping using calibrated standard sources.

For chemical analysis about 0·05 g. of the ash was dissolved in concentrated HCl and the volume made up to 50 ml. in a standard flask. The elemental composition was determined by Atomic Absorption Spectrophotometry.[4]

Results and Discussion.—The gamma-ray spectra of sample Nos. R-28 (*Ostrea madrasensis*), R-20 (*Villorita cochinensis*) and R-22 (*Pila globosa*) are given in Fig. 2. The concentrations of the radionuclides, their specific activities and the stable zinc and stable manganese contents are given in Table I.

The gamma-ray spectra of the three samples given in Fig. 2 show zinc-65 in all the species. Zinc-65 ($T\frac{1}{2}$—245 days) is a neutron-induced radionuclide which enters the environment from global fallout and as part of radioactive waste from atomic installations. Since there is no nuclear installation close to the Kerala Coast, the zinc-65 in these samples must owe its origin to global fallout.

As seen from Table I the zinc-65 and stable zinc content of *Villorita cochinensis* (100·5 μg./g. dry weight) is the highest among the three species. This value is higher than those reported by Sastry and Bhatt[2] for similar clams from Bombay (54–74 μg./g.). The lowest zinc-65 and stable zinc content is seen in *Ostrea madrasensis*. This is rather surprising

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* This work forms part of IAEA/BARC Research Agreement No. 155/R-5/CF.

since all reported data indicate higher zinc content in oysters than in clams.[2,5,6]

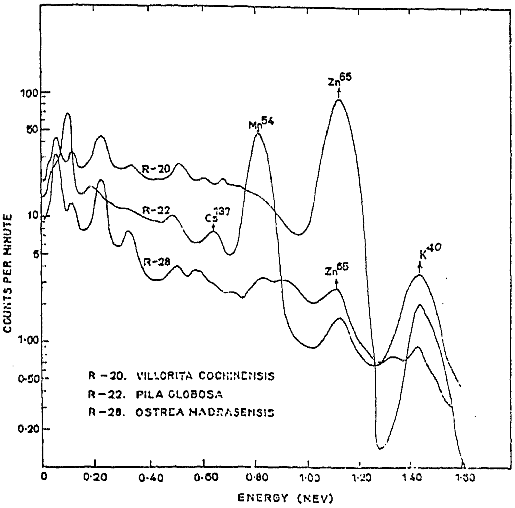

FIG. 2. Gamma-spectra of three brackish water molluscs from Kerala.

TABLE I

Radioactivity and stable element data for three brackish water molluscs from Kerala

Sample No.	Species	Ash wt. per 100 g. dry wt.	Stable element (μg./g. dry wt)		Radioactivity (uuc/g. dry wt.)			Specific activity (uuc/μg.)	
			Zn	Mn	Zn^{65}	Mn^{54}	Cs^{137}	Zn	Mn
R·20	*Villorita cochinensis* ..	11·72	100·5	18·3	118·20	nd	nd	1·176	nd
R·22	*Pila globosa* ..	10·40	80·1	303·4	1·17	11·06	1·46	0·014	0·039
R·28	*Ostrea madrasensis* ..	6·30	29·9	4·4	1·07	nd	nd	0·039	nd

nd = not detected.

The specific activities for zinc-65 in the three species show significant variations. It is worth mentioning in this connection the work of Bernhard and Zattera[7] who have shown that the rate of uptake of the stable isotope does not necessarily follow that of the radioactive isotope if the two are present in different physico-chemical states. Moreover zinc-65 being not a particularly long-lived isotope the specific activity in the tissue can vary with the age of the organism.

While zinc-65 is present in all the three species manganese-54 and caesium-137 are present only in *Pila globosa*. Manganese-54 ($T_{\frac{1}{2}}$—280 days) is formed by the neutron activation of iron and occurs in radioactive fallout from nuclear tests. Caesium-137 ($T_{\frac{1}{2}}$—30 years) also a common constituent of global fallout is a fission product radionuclide. Table I clearly demonstrates the highest manganese-54 and stable manganese content in *Pila globosa*. The manganese content, 303·4 μg./g. dry weight is considerably high compared to that reported by Vinogradov[8] for other gastropods.

The results discussed above indicate that *Villorita cochinensis* and *Pila globosa* can be considered as indicators of zinc and manganese respectively. The presence of fallout zinc-65 in all the species examined is particularly significant in view of the lack of similar data for freshwater organisms from other areas. To our knowledge the only report of zinc-65 in ground level air has come after the Chinese nuclear tests of 1967.[9]

The gastropod *Pila globosa* shows higher manganese content than the bivalve *Villorita cochinensis,* although freshwater bivalves are well-known concentrators of manganese.

Merlini *et al.*[10] reporting on manganese-54 concentration in freshwater organisms find high concentration of manganese-54 in *Unio mancus,* a bivalve while *Viviparus ater* a gastropod from the same area, showed no appreciable concentration.

Acknowledgements

Our thanks are due to Dr. A. K. Ganguly, Head, Health Physics Division, for his helpful guidance.

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LETTERS TO THE EDITOR

A NOTE ON ROTATING UNIVERSES

THE first rotating universe was invented by K. Gödel in 1949. This universe is filled with a static distribution of perfect fluid with vanishing pressure and non-zero angular velocity, the stream-lines being geodesics. There have been several attempts at generalizing Gödel's universe. Synge[1] has given a general scheme of static distribution of imperfect fluids with geodesic stream-lines and non-vanishing twist, such that when pressure becomes isotropic, the distribution reduces to Gödel's universe. Raval and Vaidya[2] have given a non-static generalization of Gödel's universe on the lines of Synge's generalization. In both the cases, the universe is filled with imperfect fluid, with geodesic stream-lines and non-vanishing twist. If v^i is the four-vector of velocity satisfying

$$v^i v_i = 1 \tag{1}$$

one can define the acceleration vector f^i and the twist or angular velocity tensor w_{ik} as

$$f^i = v^i{}_{;k} v^k \tag{2}$$

$$w_{ik} = v_{i;k} - v_{k;i} \tag{3}$$

a semicolon denoting covariant differentiation. From (2) and (3) one easily finds

$$f_i = w_{ik} v^k \tag{4}$$

Therefore $w_{ik} = 0$ implies $f^i = 0$. But the converse is not necessarily true. In the generalizations of Gödel's universe mentioned above, $f_i = 0$ and $w_{ik} \neq 0$. So that this converse is not true for these generalizations. However for perfect fluid $f_i = 0$ would always imply $w_{ik} = 0$. This restricts the possible perfect fluid distribution too severely. This can be seen as follows:

The energy momentum tensor $T_k{}^i$ for perfect fluid is given by

$$T_k{}^i = (p + \rho) v^i v_k - p g_k{}^i \tag{5}$$

The conservation law of general relativity leads to

$$(T_k{}^i)_{;i} = 0 \tag{6}$$

From (5) and (6) we obtain the "equation of motion" in the form

$$(p + \rho) f_i = p_{,i} - \frac{dp}{ds} v_i \tag{7}$$

where

$$\frac{d}{ds} = v^k \frac{\partial}{\partial x^k}$$

and comma denotes partial differentiation. With the help of (7) we can say that $f_i = 0$ imiplies

$$v_i = p_{,i} \left(\frac{dp}{ds}\right)^{-1} \tag{8}$$

provided $dp/ds \neq 0$. Substituting this v_i in $v^i{}_{;k} v_i = 0$, we can ultimately simplify it to the form,

$$p_{,i} \left(\frac{dp}{ds}\right)_{,k} - p_{,k} \left(\frac{dp}{ds}\right)_{,i} = 0 \tag{9}$$

(9) states that dp/ls is a function of p, say $\phi(p)$, and thus from (8) we conclude that v_i is the gradient of a scalar which further implies $w_{ik} = 0$. (8) further implies that the vector v_i is proportional to the gradient $p_{,i}$, i.e., that the covariant velocity vector is along the normal to the hypersurface $p =$ constant. Thus a perfect fluid distribution with geodesic stream-lines is a very restricted type of distribution, the two severe restrictions being (1) the stream-lines are normal to equipressure hypersurfaces and (2) the twist tensor $w_{ik} = 0$. Thus in case of perfect fluids if $f^i = 0$, it follows that $w_{,k} = 0$ provided $dp/ds \neq 0$. Therefore, if we wish to have perfect fluid distribution with geodesic stream-lines and non-zero twist, we must consider $p = 0$ (Gödel). On the other hand, if we wish to retain geodesic stream-lines with non-zero-twist and non-constant pressure we must forego the requirement of perfect fluid. This is what has been done in reference (2). Now in the early stage of the evolution of the universe it is expected that the radiation will dominate over matter and therefore the fluid pressure cannot be taken as zero. In that event in order to generalize Gödel's static model to the non-static case the result which we have proved in this note requires that for a model of a rotating universe filled with perfect fluid (and not dust), we must forego the requirement of geodesic stream-lines.

Dept. of Mathematics,
Gujarat University,
Ahmedabad-9, *March* 4, 1969.

L. K. PATEL.
P. C. VAIDYA.

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N.Q.R. ZEEMAN SPECTRUM OF 4-CHLORO-3-METHYL PHENOL

RESULTS of the analysis of the Zeeman quadrupole spectrum of ^{35}Cl in single crystals of 4-chloro-3-methyl phenol are reported in this note. The pure quadrupole resonance spectrum at 77° K. consists of two lines.[1] These correspond to 34·35 Mc/s. and 34·14 Mc/s. at room temperature, the former being more intense. Neither X-ray nor morphological data are available in literature for this crystal.

Single crystals grown from solution in benzene show distinct faces and are identified as of the monoclinic class, elongated along c-axis. Zeeman effect studies are carried out at room temperature rotating the crystal about the three mutually perpendicular a'-b-c-axes adopting the experimental technique already described.[2] The results are given in Table I.

TABLE I

Frequency	Axis of rotation of the crystal	C–Cl directions obtained
34·35	c	$\theta = 95^\circ\ 32'$, $\phi = 171^\circ\ 35'$ (ϕ being measured from b-axis)
	b	$\theta = 90^\circ\ 23'$, $\phi = 94^\circ\ 8'$ (ϕ being measured from c-axis)
	a'	Line not observed
34·14	c	$\theta_1 = 105^\circ\ 41'$, $\phi_1 = 53^\circ\ 31'$ $\theta_2 = 104^\circ\ 31'$, $\phi_2 = 126^\circ\ 41'$ (ϕ being measured from b-axis)
	b	Line is too feeble for Zeeman Measurements
	a'	$\theta = 64^\circ\ 42'$, $\phi = 128^\circ\ 45'$ (ϕ being measured from c-axis)

1. For a crystal of monoclinic class, only one principal z direction will be obtained according to Shimomura[3] when the z-axis lies (*i*) either in the *ac* plane or (*ii*) perpendicular to it. In the latter case one should get θ_z to be 90° if a or c is the axis of rotation and zero if b is the axis of rotation. Resonance should not be observed at all when b itself is parallel to *r.f.* axis. Since in the present case for the high frequency line only one zero splitting locus is obtained in the c-axis of rotation but with θ_z different from 90° (the difference being distinctly larger than the probable experimental error of ± 2°) one must conclude that the z-axis lies in the *ac* plane and not perendicular to it. This conclusion is supported by the further observation that when b is the axis of rotation only one zero splitting locus is similarly obtained with θ_z very nearly equal to 90°.

2. Since two z directions are obtained for the low frequency line one may conclude, according to Shimomura's deductions that these two z-axis are in general directions and may not have any simple relation with respect to the crystallographic axes. The failure to detect the second locus in the a'-axis of rotation may be because of the low intensity due to the lack of filling factor.

The above observations indicate that there should be at least two molecules in the unit cell. The asymmetry parameters calculated by the least squares method and the bond characters deduced from the above data are given in Table II.

TABLE II

Frequency	η	Double bond character per cent	Single bond character per cent	Ionic character per cent
34·35	0·07	2·33	75·74	21·93
34·14	0·12	3·97	74·75	21·28

The high η value for the second line may probably be due to the large intermolecular effects. A similar high value is obtained for *p*-chlorophenol.[4]

Zeeman measurements are carried out also with a cylindrical crystal grown from melt, for the high frequency line, the crystal being rotated about the cylindrical axis. The results are $\theta = 95^\circ\ 35'$, $\phi = 154^\circ\ 42'$ and $\eta = 0{\cdot}06$. These suggest that the growth axis may be identified to be the c-axis.

The author is indebted to Prof. K. R. Rao for his valuable guidance. She is thankful to Dr. C. B. Rao of Geology Department for the identification of the crystal. The award of a Senior Fellowship by the C.S.I.R. is gratefully acknowledged.

Magnetic Resonance Labs., B. KANTIMATI.
Department of Physics,
Andhra University,
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SPORADIC E LAYER OVER TIRUPATI

TIRUPATI is a low latitude station (latitude 13° 40′ N, longitude 79° 27′ E., geomagnetic latitude 3° 45′ N.) situated in Andhra Pradesh. Observations on the characteristics of Sporadic E layer of the ionosphere at this station have been reported[1-4] since 1960.

This report deals with some observations made during December 1968 to April 1969 on the Sporadic E layer. The Sporadic E critical frequencies (fE_s) were scaled manually on vertical incidence ionosphere sounding equipment at regular intervals of one hour during the daytime from 0900 hr. to 1700 hr. From these frequencies the hourly median values of fE_s for the entire period of five months and for each month were obtained. The diurnal variations of fE_s for the period under investigation as well as for the month of December 1968 are shown in Fig. 1. It can be inferred from this that the ionization increases with the hour of the day, reaches a maximum at about local noon and then decreases. This is a typical characteristic behaviour of Sporadic E.[5,6] However, a second maximum which is not very pronounced is observed at 1400 hr. Looking at the diurnal variation of fE_s for the month of December 1968, this second maximum is pronounced compared to other months. This particular feature has been observed at this station for over a number of years, right from 1959.[2] However, this observation of ours is not in agreement with that of Rangarajan[6] (Station: Kodaikanal, geomagnetic latitude 0° 44′ N.). A careful study over an extended period is probably necessary to elucidate this point.

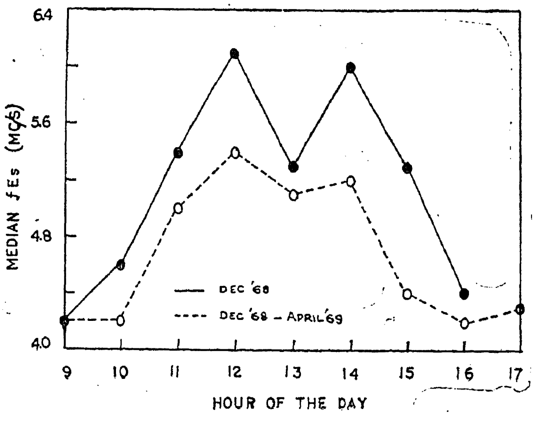

FIG. 1. Diurnal variations of fE_s.

The cumulative distribution of fE_s with frequency for the five months under study is shown in Fig. 2. Phillips[7] has shown that this semi-logarithmic plot should be a straight line for Sporadic E. However, the observed distribution (Fig. 2) deviates from linearity below 4 Mcs., and it will be noticed that in this range the per cent of times fE_s is greater than the abscissa frequency, rising sharply to 100%, instead of remaining round about 60 to 70%.

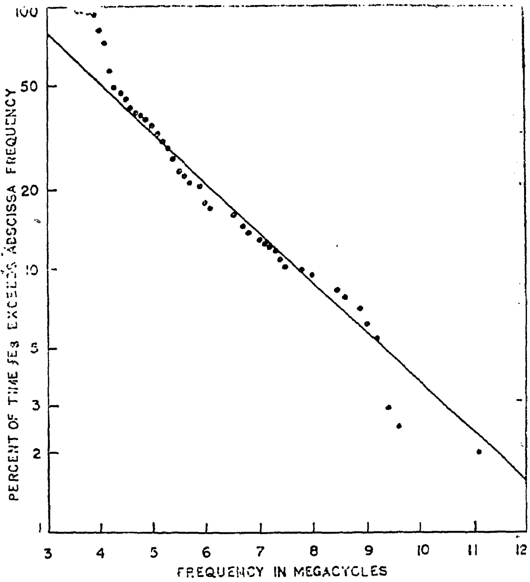

FIG. 2. The cumulative distribution of fE_s with frequency.

We are grateful to Prof. J. Bhimsenachar for his guidance and encouragement.

Physics Department, T. V. KRISHNA RAO.
Sri Venkateswara Univ., M. J. KESAVA MURTHY.
Tirupati (A.P.) India,
May 12, 1969.

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FORMATION OF LOWER OXIDE OF SULPHUR BY SOLID STATE REACTION

A SULPHUR rich oxide is formed when sulphur is allowed to combine with a limited supply of oxygen.[1] It is now observed that disulphur monoxide or its polymer is obtained by the solid state reaction between a metal sulphide and the metal (1) oxide, (2) sulphate, (3) sulphite and (4) thiosulphate. The results of a few representative experiments are reported in this short communication.

When a mixture of finely divided powders of copper sulphide and copper oxide (5 : 1 by weight) is heated at 325-350° C. under vacuum, gaseous products are released which on cooling in a trap maintained at –184° C. condense in the form of cherry to orange-red solid. The solid gives off sulphur dioxide on warming leaving a residue of elemental sulphur. Analytical results indicate that the yield of the lower oxide depends on several experimental conditions. The lower oxide is identified to be the Disulphur Monoxide by the methods described earlier.[2] The fact that the reaction between copper sulphide and copper oxide takes place well below the decomposition temperature of both the sulphide and oxide lends support to the view that this is a solid state reaction.

Similar reaction is observed to occur at about 400° C. between the following systems with the release of the lower oxide: (1) copper sulphide-copper sulphate, (2) copper sulphide-copper sulphite, (3) copper sulphide-copper thiosulphate and (4) copper sulphide-copper chromate. Experiments with other metal sulphides such as of nickel, cobalt and iron also yielded the lower oxide in good yield. Further work is in progress.

Dept. of Inorgonic and Physical Chemistry,
Indian Institute of Science,
Bangalore-12, June 11, 1969.

T. R. NARAYANAN KUTTY.
A. R. VASUDEVA MURTHY.

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CONDUCTOMETRIC STUDY OF SOME COBALTICYANIDES

ABSTRACT

The stoichiometric relationship and the solubility of zinc cobalticyanide and the dissociation constant of ion-pair have been studied from conductivity measurements.

THE conductivity bridge employed in this study has been described earlier.[1] Zinc sulphate, copper sulphate, nickel sulphate (E. Merck, G.R.) and potassium cobalticyanide (B. D. H.) recrystallised from a water-dioxane mixture were used for preparing stock solutions with conductivity water.

Zinc Cobalticyanide System.—Conductometric (both forward and reverse) titrations of zinc sulphate (Fig. 1 and Table I) with potassium cobalticyanide revealed an inflection point at 1·5 indicating the formula of the complex to be $Zn_3\ [CO(CN)_6]_2$.

TABLE I

Conductometric titrations

$K_3Co(CN)_6 = 5 \times 10^{-2}$ M $ZnSO_4 = 5 \times 10^{-2}$ M
Volume = 15·6 ml.

Zn^{++} ml.	$K_3CO(CN)_6$ ml.	Ratio of Zn^{++} to $CO(CN)_6^{-3}$
(Direct titration)		
0·6	0·415	1·45
1·0	0·65	1·54
1·5	0·98	1·53
(Reverse titration)		
0·75	0·5	1·50
1·05	0·7	1·50

For conductivity measurements, zinc cobalticyanide, prepared by precipitation, was filtered, washed well and kept suspended in conductivity water for several days. The sample was filtered and dried *in vacuo*. The resistance of solutions at different concentrations of zinc cobalticyanide was measured. A plot of Λ *vs.* $\sqrt{C}$ (Fig. 2), as compared with the theoretical Onsager curve, was similar to that of a weak electrolyte which could be explained on the basis of ion-pair formation.[2,3] The dissociation constant of the ion-pair $[Zn\ CO(CN)_6]^-$ was calculated from the measured conductances.

The Onsager's equations for complete dissociation and dissociation to ion-pair are

$$\Lambda_1 = 151 \cdot 7 - 362 \cdot 97 \sqrt{I}$$
$$\Lambda_2 = 85 \cdot 67 - 128 \cdot 5 \sqrt{I}$$

The ionic strength, I, can be calculated from

$$I = C(2 \cdot 5 - 2\alpha)$$

where C is the concentration in g. eq./litre. The measured equivalent conductance, Λ, can therefore be written as

$$\Lambda = 151 \cdot 7 - 362 \cdot 97 \sqrt{I} - \alpha\ (123 \cdot 1 - 320 \cdot 15 \sqrt{I})$$

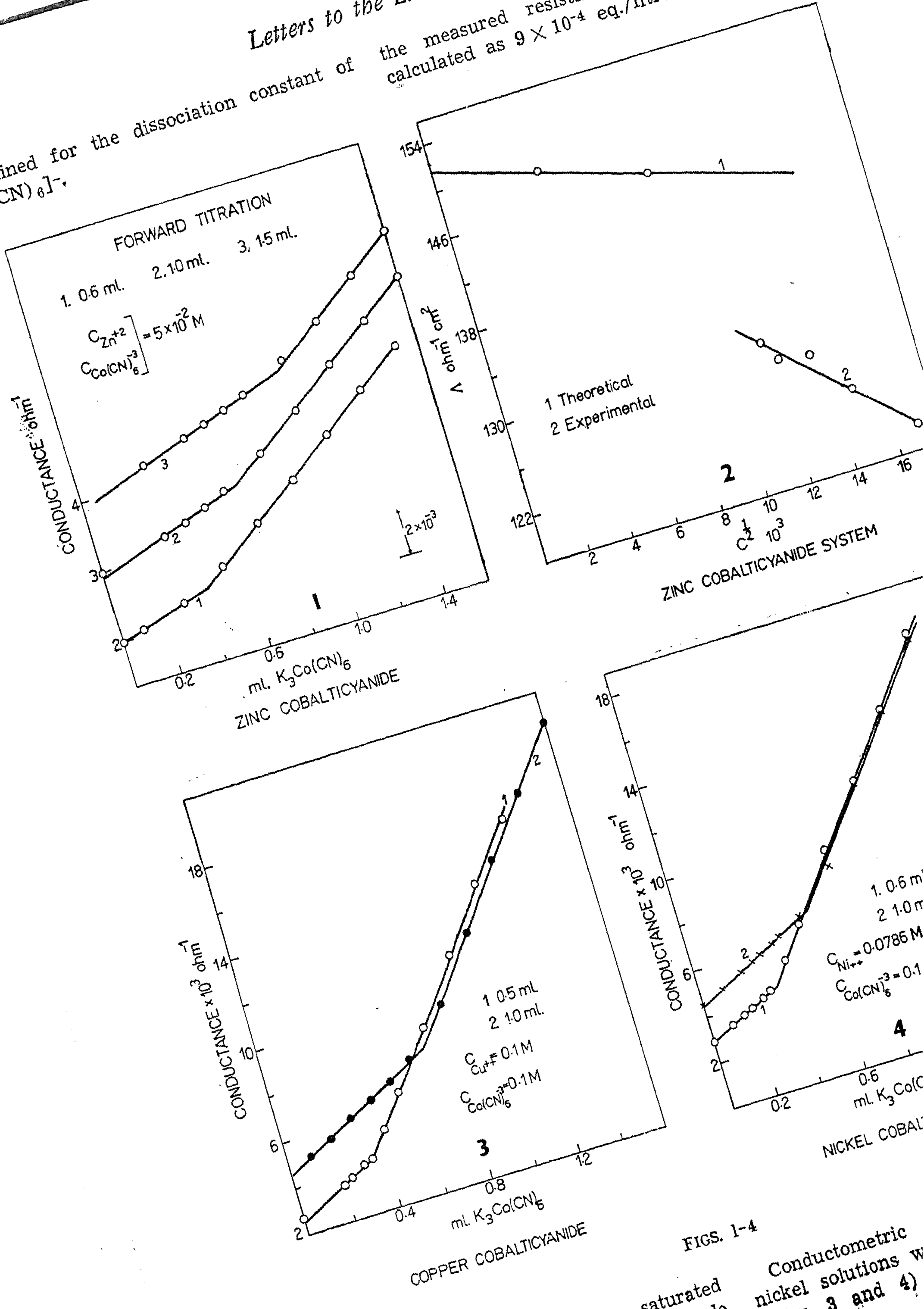
from which α, the degree of dissociation of ion-pair can be calculated by successive approximation. The thermodynamic dissociation constant can then be calculated from

$$\log K = \log \frac{C(1 \cdot 5 - \alpha)(1 - \alpha)}{3\alpha} - 6 \cdot 108\ I^{\frac{1}{2}}.$$

The calculated values of α and K are given in Table II. An average value of $3 \cdot 5 \times 10^{-4}$

was obtained for the dissociation constant of $[Zn\,Co(CN)_6]^-$.

the measured resista
calculated as 9×10^{-4} eq./litre.



FIGS. 1-4

For solubility measurements, a saturated solution was prepared by shaking the sample in conductivity water for several hours. From

Conductometric
nickel solutions w
(Figs. 3 and 4)

$Cu_3\ [Co(CN)_6]_2$ and $Ni_3\ [Co(CN)_6]_2$. No further measurement could be carried out because of very low solubility.

TABLE II

Conductance of zinc cobalticyanide solutions

$C.10^4$ g. eq.L^{-1}	$C^{\frac{1}{2}}.10^2$ [g. eq.$L^{-1}]^{\frac{1}{2}}$	Λ Ω^{-1} cm.^{2}	α	$K.10^4$
1·360	1·16	130·3	0·13	3·3
1·463	1·21	128·6	0·14	3·1
1·813	1·35	128·2	0·14	3·9
2·195	1·48	124·5	0·17	3·6
2·926	1·71	120·1	0·19	3·7

The authors wish to thank Dr. V. T. Athavale for his kind interest.

Analytical Division,
Bhabha Atomic
Research Centre,
Trombay, Bombay-85,
March 25, 1969.

S. C. SARAIYA.
A. K. SUNDARAM.

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EFFECT OF β-HYDROXYBUTYRATE ADMINISTRATION ON REDUCED GLUTATHIONE CONTENT OF BLOOD AND LIVER OF RATS

A PROGRESSIVE depletion of blood reduced glutathione (GSH) was earlier observed in rabbits injected with a single dose or prolonged administration of acetoacetate.[1] A similar decrease in liver GSH content was also observed in acetoacetate treated animals.[2] β-hydroxybutyrate (BHB), another member of ketone bodies, was shown to deplete liver GSH levels after sixty days of injection in rats.[3] The effect of acetoacetate can be understood in view of the postulations of Lazarow,[4] who stated that the deleterious effect of acetoacetate may be due to the reaction of the carbonyl group with GSH or SH containing enzymes. However, as BHB is devoid of a carbonyl function, its mechanism of action is not similar to that of acetoacetate. But BHB is known to be converted to acetoacetate in the animal system.[5] So, to consider whether the GSH depressing action of BHB is mediated through the formation of acetoacetate, the effect of a single massive dose of BHB on GSH and acetoacetate content of blood and liver of rats was investigated.

The hydrolysed product of glucose cycloacetoacetate (GCAh) was earlier shown to be a ketolytic compound.[6] It is known to prevent the fall of blood GSH content of animals injected with acetoacetate.[7] Hence the effect of GCAh on blood and liver GSH content of BHB injected animals was also studied.

12 male albino rats (150–160 g.) maintained on a stock laboratory diet were divided equally into three groups. Group I animals received isotonic saline (1 ml.) and acted as controls. Animals of Group II were subcutaneously injected with an aqueous solution of sodium salt of β-hydroxybutyrate (BHB) (200 mg./Kg. body weight). Group III animals received GCAh (100 mg./Kg. body weight) along with BHB in a similar route. After every 30 min. intervals of BHB administration, blood was drawn from the cut tail ends of rats from each group and pooled separately. This pooled blood was subjected to the estimation procedures of GSH and acetoacetate. After 3 hr. all the rats were killed by decapitation and livers were removed. Estimation of GSH and acetoacetate was carried out on these livers. GSH content of liver and blood was determined by following the method used by Buttler.[8] Blood and liver acetoacetate were determined according to the method of Peden[9] and Greenberg and Lester[10] respectively. GCAh was prepared as per the procedures of Nath and Nath.[11]

For the first one hour after BHB injection, both the levels of blood GSH and acetoacetate were found to be steady with almost no alterations (Fig. 1). A progressive depletion of GSH starts after one hour and proceeds further till the lowest value is reached at the end of two hours. This is followed by an immediate rise of GSH to the normal values as in controls. Similarly, a steady lag phase of one hour precedes a steep increase in the acetoacetate accumulation, reaching the maximum level at the end of two hours. Afterwards, acetoacetate concentration was found to decline to normal values within half-an-hour. But, even at the end of three hours after BHB injection, the liver GSH content was found to be significantly less than that of controls (Table I). At this stage, the concentration of acetoacetate in liver is almost twice that of control. GCAh administration along with BHB is shown to arrest the fall of GSH content of blood as well as check the accumu-

TABLE I

Effect of β-hydroxybutyrate (BHB) administration on liver GSH and acetoacetate content after 3 hr.

Group	Liver GSH mg/g. (mean ± S.D)	 Acetoacetate mg./g. (mean ± S.D.)
I Control ..	1·30 ± 0·14	0·50 ± 0·05
II BHB injected ..	0·72 ± 0·11	0·98 ± 0·04
III GCAh + BHB injected	1·25 ± 0·21	0·57 ± 0·05

lation of acetoacetate (Fig. 1, Table I). Similar results were also obtained with liver GSH and acetoacetate (Table I). These results (Fig. 1 and Table I) showing no fall in GSH content till the time acetoacetate accumulation is considerably high, a maximum drop in GSH when the concentration of acetoacetate is the highest and a prompt elevation of GSH levels following the decline of acetoacetate content, strongly suggest an inverse relation between these two.

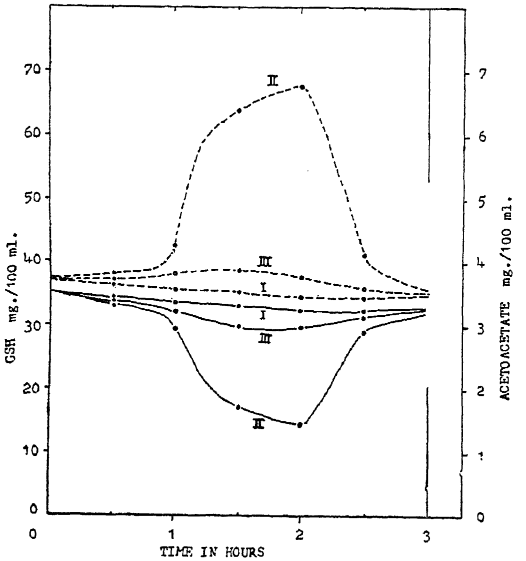

FIG. 1. Effect of β-hydroxybutyrate (BHB) on blood GSH and acetoacetate contents with time. The dotted lines indicate the amount of acetoacetate formed with time whereas continuous lines indicate that of GSH I. control, II. BHB injected, III. GCAh + BHB injected.

The initial lag period (Fig. 1) rules out any direct effect of BHB on GSH content. It has been reported that BHB is converted to acetoacetate in the animal system.[5] Further, a steep rise in acetoacetate after one hour lag phase followed by a progressive depletion of blood GSH (Fig. 1) reveals that the fall of GSH brought about by BHB is only a secondary one to its conversion to acetoacetate. Previously, BHB was reported to cause a profound fall in the liver GSH after sixty days of injection, whereas our results indicate such deleterious effects of BHB on blood and liver GSH contents even after a single dose of administration.

Earlier GCAh was reported to be a ketolytic compound.[6] Our results (Fig. 1 and Table I) are in confirmation with those observations. The alleviation of GSH content produced by GCAh in BHB injected animals is in line with similar protective effect exerted by it on acetoacetate administered animals.[7] Thus the beneficial role of GCAh on GSH can be well understood in view of its ketolytic property.

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University Dept. of Biochemistry,
Nagpur, *April* 2, 1969.

B. SIVAKUMAR.
M. C. NATH.

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SYNTHESIS OF 3-ARYL-4-METHYL-7-HYDROXY COUMARINS

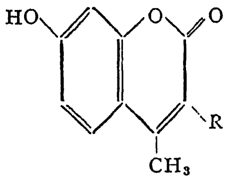
THE arylation of hydroxy coumarins has been shown to yield corresponding 3-arylhydroxy coumarins.[1-6] In the present study, Meerwein arylation reaction has been applied to 4-methyl-7-hydroxy coumarin[7] to give the desired 3-aryl-4-methyl-7-hydroxy coumarins (I).

A filtered diazo solution prepared from a primary amine (0·01 mole), sodium nitrite and hydrochloric acid was added to a stirring solution of 4-methyl-7-hydroxy coumarin in acetone and sodium acetate in a small amount

TABLE I

Sl. No.	R	Colour	m.p.° C.	Yield %	Molecular formula	Analysis % Carbon Calcd.	Carbon Found	Hydrogen Calcd.	Hydrogen Found
1	Phenyl	Brown	220–21	10	$C_{16}H_{12}O_3$	76·17	76·38	4·80	5·21
2	*o*-Methylphenyl	Brown	265–67	2	$C_{17}H_{14}O_3$	76·67	76·15	5·30	5·62
3	*m*-Methylphenyl	Reddish-brown	243–45	3	$C_{17}H_{14}O_3$	76·67	76·28	5·30	5·75
4	*p*-Methylphenyl	Reddish-brown	258–60	11	$C_{17}H_{14}O_3$	76·67	76·35	5·30	5·45
5	*o*-Methoxyphenyl	Chocolate	263–65	3	$C_{17}H_{14}O_4$	74·33	74·12	5·00	5·33
6	*m*-Methoxyphenyl	Chocolate	250–51	3	$C_{17}H_{14}O_4$	74·33	74·08	5·00	5·45
7	*o*-Nitrophenyl	Orrange-red	263–65	3	$C_{16}H_{11}NO_5$	64·65	64·15	3·73	3·35
8	*m*-Nitrophenyl	Orange-red	253–55	2	$C_{16}H_{11}NO_5$	64·65	64·23	3·73	3·52
9	*p*-Nitrophenyl	Orange-red	220–22	12	$C_{16}H_{11}NO_5$	64·65	64·43	3·73	3·97
10	*o*-Chlorophenyl	Brown	278–79	3	$C_{16}H_{11}ClO_3$	67·02	66·61	3·87	4·12
11	*m*-Chlorophenyl	Reddish-brown	251–52	5	$C_{16}H_{11}ClO_3$	67·02	66·84	3·87	4·22

of water, the pH being then approximately 5. No gas evolution was noticeable (temp. 20° C.). On gentle warming and addition of copper chloride in a small amount of water, the gas evolution set in. Finally, the solution was heated to 35° C. The mixture was then steam-distilled to remove acetone. The remaining solid was extracted several times with boiling water and the residue was crystallized from dilute acetic acid.



I

These compounds are intensely coloured and their yields varied from 2% to 12%. The physical characteristics of these compounds are given in Table I.

Department of Chemistry, J. N. GADRE.
Ramnarain Ruia College, R. A. KULKARNI.
Bombay-19, *February* 8, 1969.

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OCCURRENCE OF TAZETTINE AND HAEMANTHIDINE IN THE BULBS OF *HYMENOCALLIS CONCINNA* BAKER

WE record here the results of the chemical investigation of *Hymenocallis concinna* Baker. (Syn. *H. dillenii* Roem.) native to Mexico, but naturalised in several parts of India.

The fresh bulbs were minced and extracted with alcohol. The combined alcoholic extract was concentrated under reduced pressure to an aqueous phase, made acidic to pH 6 and extracted with immiscible solvents. No crystalline substance could be obtained from the residues of these extracts. The aqueous liquid was then made alkaline to pH 8 and extracted with chloroform. The residue from this extract yielded two crystalline alkaloids (A and B) in yields of 0·03 and 0·008% respectively by chromatography over alumina.

Alkaloid A crystallized as colourless prisms from acetone, m.p. 205–207°, $[\alpha]_D$ + 164·3° (chf.). It gave a positive gallic acid test for a methylenedioxy group and analysed for the formula $C_{18}H_{21}NO_5$. It formed a monoacetate, $C_{20}H_{23}NO_6$, m.p. 124–26°, $[\alpha]_D$ + 74·2° (ethanol), a picrate, m.p. 210–12° (dec.), a methiodide, m.p. 235–38° (dec.) and a hydrochloride, m.p. 215–18° (dec.). These properties closely resembled those of tazettine and its corresponding derivatives. The identity was established by direct comparison, mixed m.p., t.l.c. and superimposable i.r. spectra, with authentic tazettine obtained from *H. harrisiana*.[1]

Alkaloid B crystallized as polyhedral prisms from acetone, m.p. 188–90°, $[\alpha]_D$ − 46·3° (chf.). It contained a methylenedioxy group and analysed for the formula $C_{17}H_{19}NO_5$. It formed a diacetate, $C_{21}H_{23}NO_7$, m.p. 218–20° and a picrate, m.p. 204–206° (dec.). These properties suggested that the alkaloid could be hæmanthidine and this was confirmed by direct comparison, mixed m.p., t.l.c. and superimposable i.r. spectra, with authentic hæmanthidine obtained from *H. harrisiana*.[1] The identity was further confirmed by converting alkaloid B into tazettine, m.p. and m.m.p. 206–208°, using Boit's procedure.[2]

It is of interest to note that tazettine which is one of the more abundant of the Amaryllidaceæ alkaloids has been isolated from all the *Hymenocallis* species examined so far, but hitherto only *H. harrisiana*[1] and *H. americana*[3] were reported to contain both tazettine and hæmanthidine. Hæmanthidine has been shown to be the precursor of tazettine in *Sprekelia formosissima*.[4]

Our thanks are due to Prof. L. Ramachandra Row for the i.r. spectra.

Dept. of Pharmacy, Andhra University, Waltair, *April* 24, 1969.
E. Venkata Rao.
Mrs. M. Vimala Devi.
R. V. Krishna Rao.

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RANA CYANOPHLYCTIS AS THE SECOND INTERMEDIARY OF *ARTYFECHINOSTOMUM SUFRARTYFEX* (ECHINOSTOMATIDAE : TREMATODA)

One of the several types of metacercarial cysts, recorded in the common snails: *Digoniostoma pulchella* (Benson), *Indoplanorbis exustus* "Deshayes" and *Lymnea luteola* f. *australis* (Annandale and Rao), was found to develop, in laboratory-raised white rats and a clean piglet, into *Artyfechinostomum sufrartyfex* Lane, 1915. The droppings of the infected rats became positive for the characteristic eggs on the 16th day after infection and from the piglet, slaughtered on the 45th day after infection, a well-developed mature fluke was recovered.[3]

A. sufrartyfex, widely prevalent in our pigs, has also been reported from rats,[4] honey-badger—*Mallivora indica* (Kerr),[9] dog,[2] and man.[5-8]

During examination of numerous specimens of the common pond-frog (*Rana cyanophlyctis*) captured from several ponds at Raya (13 Km. away from Mathura), the kidneys were heavily infested with cysts of an echinostome metacercaria. These cysts, on the total number of collar spines, were distinguishable into two types—43 in one and 55 in the other. On the morphology of the cystic and the excysted forms, the cyst with 43 collar spines conformed to the description of the metacercaria of *A. sufrartyfex* as given by Matta and Pande.[3] To confirm this specific determination, 500 cysts were fed to a clean laboratory-reared pup (weaned after birth) and a clean rabbit. These experimental animals were kept in separate cages. Prior to administering the infection, periodical fæcal examinations were negative for any helminthic infections.

The infected pup, on autopsy on the 25th day after infection, yielded 3 mature flukes from the small intestine. The droppings of the rabbit, regularly examined from 20th day after the infection, became positive for the characteristic eggs on the 23rd day. On slaughter, 14 specimens were recovered from the small intestine.

On comparison with the numerous specimens of *A. sufrartyfex* available in the Department and from a perusal of the published accounts,[1,3] the collection from these two experimental animals revealed an identical pattern in matter of body-size, general topography and the overall morphology. The 23-day old specimens from the rabbit were, however, with a slightly greater range in body-size than the 25-day old specimens from the pup. An addition to the morphology given by Ahluwalia[1] relates to the character of the main stem of the excretory bladder which, in the adult specimens, receives 6-8 lateral branches on each side.

The present finding of metacercarial cysts of *A. sufrartyfex* in our common pond-frog, though in conformity with the previous reports from abroad of several anurans acting as second intermediary of echinostomes,[10] enlarges the known range of the second intermediate hosts in this region. Successful development of the metacercaria to the mature fluke has also been demonstrated in a rabbit and a pup.

Grateful acknowledgements are expressed to Dr. B. P. Pande, Professor of Parasitology, for

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Dept. of Parasitology, DHARMENDRA NATH.
U.P. College of Veterinary
Science and Animal
Husbandry,
Mathura (U.P.), *April* 19, 1969.

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AN ABERRANT LIFE-HISTORY IN *GRACILARIA EDULIS* (GMEL.) SILVA AND *GRACILARIA CORTICATA* J. AG.

AN attempt was made to culture *Gracilaria edulis* and *G. corticata* from carpospores under laboratory conditions and then transfer the sporelings to the sea to obtain adult plants. The experiment was carried out at Mandapam Camp and in the South Bay of Krusadi Island in the Gulf of Mannar. Fresh healthy plants of *G. edulis* and *G. corticata* were collected, washed thoroughly in filtered sea-water and suspended over a piece of nylon fabric in a trough of filtered sea-water so that carpospores were shed on to the fabric. In about ten days, the spores germinated and the sporelings were firmly attached to the fabric. The fabric was then removed and cut into thin strips. The strips were then wound round a coir rope and the rope was transferred to the sea and fixed at low water level. One half of the rope carried sporelings of *G. edulis* and the other half, those of *G. corticata*.

Four months after the sporelings were outplanted, the rope was covered with young plants of *G. edulis* and *G. corticata*. It took another four months for the plants of both species to grow to maturity and develop reproductive structures. The most surprising observation was that all the plants developed were, in both species, cystocarpic. Neither antheridial nor tetrasporic plants were observed. Thus, starting with carpospores, cystocarpic plants were obtained, eliminating the tetrasporic phase.

Drew[1] defined life-history as "the observed sequence or sequences of somatic and nuclear phases known for the species under consideration". Such sequence or sequences can only be observed in culture. However, so far there has been no attempt to observe these sequences in culture in *Gracilaria*. The present attempt has resulted in the surprising sequence described above.

The above observation poses interesting cytological and cytogenetical problems. It is generally believed that the carpospores of Florideophyceæ are diploid and Magne[2] has produced sufficient evidence to support such an assumption. But in the two species studied, one of three events is possible: (1) The cystocarps in these species may have developed without sexual fusion and the carposporophytes and the carpospores may be haploid, resulting in a repetition of the sexual phase bearing only cystocarps. The occurrence of only cystocarpic plants in this generation may be explained by assuming that antheridial and carpogonial plants are distinguished by the presence of sex chromosomes of some type. If there had been no fertilization, then, only carpogonial plants would have been produced, as in the present instance. (2) The carpospores are produced in the normal manner and so are diploid, but there is a reduction division during the germination of the spore and so a haploid sexual plant is produced. This eliminates the tetrasporic phase. However, under this assumption, it is hard to explain the complete absence of antheridial plants. (3) The carpospores may be diploid and if so, the cystocarpic plants produced in the experiment should be diploid, suggesting the possibility of polyploidy in these algæ. The carposporophytes in these two species may be either triploid or tetraploid, produced in a manner similar to that suggested for *Spermothamnion turneri*.[3-5] In such a case also, the complete absence of antheridial plants is hard to explain. A cytological investigation alone will settle this interesting problem and such an investigation has been taken up.

CSMCRI Marine Algal Research Station,
Mandapam Camp,
March 4, 1969.

V. KRISHNAMURTHY.
P. VENKATARAJU.
R. VENUGOPAL.

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SCHISTOSOMA (?) *INDICUM* IN AN ELEPHANT

Schistosoma indicum has been reported by several workers in various types of domesticated animals.[1] But so far no incidence has been recorded in the elephant (*Elephas maximus indicus*), though Mudaliar and Ramanujachary[2] described *Schistosoma nairi* from it.

Fæcal samples were collected from elephants at Tirupati and examined for parasitic infestations. One animal revealed ova resembling those of *Schistosoma indicum.* On further daily examination for about a week, same type of eggs were observed.

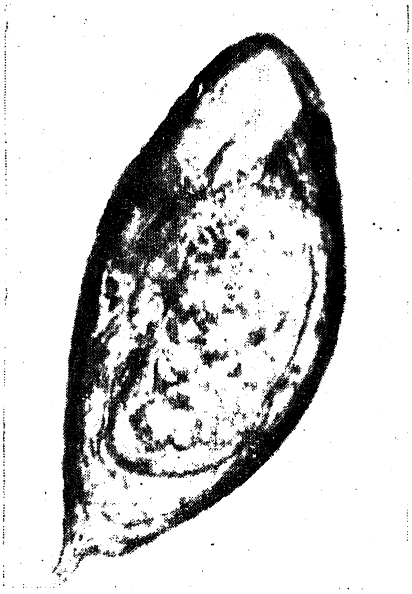

FIG. 1. Photomicrograph of an egg of *Schistosoma indicum*, × 525.

The eggs were elongately oval, with smooth cuticle and a spine at one end. They measured 112–156 μ (average 133 μ) in length and 58–82 μ (average 72 μ) in breadth. The length of the spines ranged from 7 to 13 μ (average 9·5 μ) and the width was 4 to 8 μ (average 6·2 μ) at their base. The tips were blunt. Most of the eggs contained fully developed miracidia except a few in which the miracidia were in developing stages.

This differs from *Schistosoma nairi* (80 μ × 30 μ) being bigger in size with both ends alike and also by the absence of shell ridges or rugæ. The eggs described here are similar to that of *Schistosoma indicum*,[1] but the precise identity of the worm and its location are yet to be determined.

The authors are grateful to Dr. P. S. Rajulu, Principal, Dr. Ganti A. Sastry and Dr. A. Venkataratnam for their encouragement. They are also thankful to Dr. T. Ramabrahmaiah, Superintendent, S. V. Dairy Farm, Tirupati, for his help.

Department of Pathology and Parasitology,
College of Vet. Sci.,
Tirupati (A.P.), *March* 12, 1969.

N. SATYANARAYANACHARYULU.
T. SUBBA RAO.
K. JAMES CHRISTOPHER.

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NEW RECORDS OF INTER-TIDAL BARNACLES FROM INDIA

THIS preliminary note communicates the occurrence of two forms of sessile barnacles which are new additions to the known Cirripedian fauna of India. They are *Tetraclita (Tetraclita) squamosa rufotincta* Pilsbry, 1916 ; and *Balanus amphitrite* var. *stutsburi* Darwin, 1854.

The specimens of *T. s. rufotincta* were collected at Okha (Lat. 22° 28′ N., Long. 69° 05′ E.) and Veraval (Lat. 20° 54′ N., Long. 70° 22′ E.). They were well developed, having rostro-carinal diameter of 20–25 mm. The colour of the shell is reddish-pink. The surface of the shell is eroded, showing fine short ridges. The sutures are not visible externally. The opercular valves are more whitish on their inner sides resembling to the forms described from Prison Island, Zanzibar. The rest of the description agrees very well with the original one given by Pilsbry. The shells were encrusted with *Chthamalus* sp. indicating their position in the inter-tidal zone.

Forms of *B.a. stutsburi* were observed at three widely separated localities. They were Trombay—near Bombay (Lat. 19° 00′ N., Long. 72° 55′ E.), Panaji—Goa (Lat. 15° 25′ N., Long. 73° 54′ E.) and Mangalore (Lat. 12° 51′ N., Long. 74° 50′ E.). The specimens collected from Bombay are typical or fully coloured, much larger in size and possess comparatively stronger shell compartments. As described by Stubbings (1961) the shell is conical and has a robust appearance. There is also incurving of compartments towards the shell opening, so that the shell presents a convex appearance in profile. As compared, the specimens collected at Panaji and Mangalore are smaller and their shells are devoid of pigment. This variety is distributed on West African coast. An interesting point about the occurrence of these forms is that all the three localities where they were collected are situated near the openings of river-mouths into the sea. Thus, there seems to be some resemblance to their ecological conditions.

Our best thanks are due to Prof. Dr. Utinomi, Director, Seto Marine Biological Laboratory, Japan, for his willing help in identification. One of us (A. B. W.) thanks the Ministry of Education, Government of India, for the award of Research Training Scholarship and the Indian National Committee on Oceanic Research for the award of the fellowship during the tenure of which this survey was carried out at the Institute of Science, Bombay.

National Institute of Oceanography, A. B. WAGH.
Miramar, Panaji-Goa,
and
Kirti College, D. V. BAL.
K. Dhuru Road,
Bombay-28, *March* 12, 1969.

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PRESENCE OF ACID MUCOPOLYSACCHARIDE IN THE CUTICLE OF A MILLIPEDE *CINGALOBOLUS BUGNIONI*

STUDIES on calcification of tissues in vertebrates showed the essential role of acid mucopolysaccharides in biological calcification.[1] Mucopolysaccharides seem to be important in calcification of tissues in the digestive gland of molluscs and cuticle of crustaceans.[2-4] The cuticle of millipedes is known to be heavily calcified[5,6] but it is not known if mucopolysaccharides are involved in the calcification. The present study on the millipede *Cingalobolus bugnioni* Carl was undertaken with the object of investigating the nature and role of mucopolysaccharides, if any, in the calcification of the cuticle. The histochemical tests employed for this purpose include Periodic acid-Schiff (PAS) test as modified by Gomori,[7] Mowry's modification of alcian blue method,[8] toluidine blue method of Kramer and Windrum[9] and the methylene blue extinction technique.[10]

The cuticle of *Cingalobolus bugnioni* was positive to PAS reaction even after preliminary digestion with diastase and after pyridine extraction suggesting that the PAS-positivity may not be due to glycogen or lipids.[11] It is known that diastase-stable PAS-positive compounds include such carbohydrate substances as acid mucopolysaccharide, mucoproteins or neutral mucopolysaccharide and such lipid compounds as glyco or phospholipids and lipoproteins.[11]

Acid mucopolysaccharide may be distinguished from mucoprotein and neutral mucopolysaccharide by the ability of the former to exhibit gamma-metachromasia. The cuticle of *Cingalobolus* when treated with toluidine blue demonstrated gamma-metachromasia by staining reddish-purple, suggesting the presence of acid mucopolysaccharide. The metachromasia was not removed by washing with 95% ethanol indicating the presence of ester sulphate groups.[9]

Alcian blue stained the cuticle an intense blue-green at pH 2·7. There was staining at pH 1·8 also, but the reaction was not so intense. Staining at pH 2·7 indicates the presence of acid mucopolysaccharide and staining at pH 1·8 indicates acid mucopolysaccharide containing sulphuric acid groups.[8,11] The presence of compounds with strong acid radicles is confirmed by methylene blue staining at pH 2·7.

A chromatographic analysis of the material in question indicates that the sugar components in it are fucose, galactosamine and mannose. In *Hemigraspus nudus* the acid mucopolysaccharide was shown to contain sugars like fucose, galactose and glucose. The work of Leblond *et al.*[12] suggests that the mucopolysaccharides in calcified tissues may show a variety of sugars such as galactose, fucose and sialic acid.

It may be inferred from the observations reported above that acid mucopolysaccharides are involved in calcification of tissues but their nature pertaining to the sugar constituents may vary widely.

I am thankful to Professor G. Krishnan for providing facilities and for his interest in this study.

Dept. of Zoology, G. SUNDARA RAJULU.
University of Madras,
Madras-5, *May* 27, 1969.

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MODIFIED BURTON'S MEDIUM FOR LARGE-SCALE PRODUCTION OF CULTURE OF *RHIZOBIUM JAPONICUM*

VARIOUS culture media have been used in the industrial propagation of rhizobia. Sucrose or mannitol are the usual carbon sources. These compounds serve well when used in the laboratory but when inoculants are to be manufactured on a large scale, a cheap and readily available energy source is necessary. Because of the increasing importance of the soybean and the benefits to be derived from its inoculation we evolved a suitable medium for its manufacture. The present communication deals with the growth of *Rhizobium japonicum* in this medium.

The medium employed here was modified from that described by Burton[1] and consisted of malt extract, 10 gm.; mannitol, 2 gm.; K_3PO_4, 0·10 gm.; KH_2PO_4, 0·37 gm.; $MgSO_4 . 7H_2O$, 0·18 gm.; NaCl, 0·06 gm.; $(NH_4)_2HPO_4$, 0·10 gm.; $CaSO.2H_2O$, 0·04 gm.; $CaCO_3$, 0·25 gm.; yeast extract, 1·00 gm. and water, 1000 ml. In the interest of economy, sucrose used by Burton was replaced by malt-extract (Mohan Meakin Breweries Ltd., Ghaziabad) which besides being cheap, had been found to be an excellent growth source for fast growing *Rhizobium*.[2]

Six strains of *Rhizobium japonicum* were grown in the above medium and were continuously shaken in a rotary shakre for 7 days at 28° C. Standard yeast-extract-mannitol medium and Burton's medium were used for comparison.

Plate counts of each species were made by standard dilution procedures[3] in the yeast-extract-mannitol agar containing Congo red (1 in 40,000). The results are given in Table I.

TABLE I

Counts of different strains of Rhizobium japonicum *in the three test media* (*Average of duplicates*)

Strain	Yeast-extract-mannitol medium	Burton's medium	Modified Burton's medium
b 120 ..	5×10^9	33×10^{11}	120×10^{11}
b 121 ..	10×10^{10}	30×10^{11}	47×10^{11}
b 125 ..	30×10^{11}	55×10^{11}	140×10^{11}
U.S D.A. *b*-136	40×10^{11}	60×10^{11}	142×10^{11}
Nanking ..	4×10^{13}	6×10^{13}	6×10^{13}

From the results presented in Table I it can be seen that the growth in both Burton's medium and in the modified medium were comparable but that the counts were invariably more in the modified medium.

The authors are grateful to Dr. W. V. B. Sundara Rao for his suggestion and keen interest in this work.

Division of Microbiology, V. ISWARAN.
I.A.R.I., New Delhi-12, P. H. GRAHAM.*
March 7, 1969. K. S. JAUHRI.

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* Department of Microbiology, University of Sydney, Sydney.

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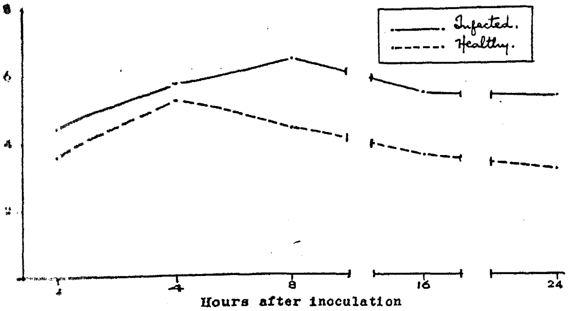
E EFFECT OF DOLICHOS ENATION MOSAIC VIRUS ON THE ESPIRATION OF LEAF TISSUE OF CLUSTER BEANS (*CYAMOPSIS TRAGONOLOBA*)—A LOCAL LESION HOST OF THE VIRUS*

e effect of Dolichos enation mosaic virus EMV)[1] infection on the respiration of leaf ue of its local lesion host, *Cyamopsis agonoloba*[2] is reported here.

standard inoculum of the virus[3] was hed uniformly on the cotyledonary leaves one batch of 7-day old cluster bean plants sed in pots in the greenhouse, using 'celite' abrasive, while another batch of plants of same age rubbed with 'celite' suspended distilled water served as control. The ves were washed with distilled water soon r rubbing. The plants were incubated at C. before and after inoculation. The rate oxygen uptake of leaf discs taken from se plants was studied 2, 4, 8, 16 and 24 hr. r inoculation. Lesions became discernible the 25th hour after inoculation. The gen uptake was measured by the manotric method[4] with 15 leaf discs suspended Sorensen's buffer of pH 5·6 in each vessel. The results are presented in Fig. 1. It seen that in both the inoculated and control nts, the respiratory rate shows an increase o the 4th hr. The rate continues to rise adily in the inoculated leaves, reaching a ak value around 8 hours after inoculation. the controls the rate falls after the 4th hour l by the 16th hour the initial rate has been tored. In the inoculated leaves the respiory rate is appreciably higher than that of controls from the 8th hour after inocula n till the end of the experiment.



ig. 1. Rate of Oxygen uptake by the leaves of healthy DEMV infected cluster bean.

According to Yamaguchi and Hirai[5] respiory rate increases in leaves of *Nicotiana glutinosa* inoculated with TMV only after the appearance of local lesions and reflects the development of lesions. Farkas *et al.*[6] report an increased activity of oxydative enzymes in leaves of local lesion hosts following appearance of lesions. Weintraub *et al.*,[7] however, report an increase in the rate of respiration even before the appearance of local lesions. He considers that the respiratory rise is due to virus activity and not due to necrotisation. The increase in respiration observed here before the appearance of lesions is probably due to the activity of the virus in the infected cells as suggested by Weintraub *et al.*

The author is grateful to Prof. T. S. Sadasivan, Director, University Botany Laboratory, for guidance and encouragement.

University Botany Laboratory,
Madras-5, *March* 14, 1969.
A. RAMADASAN.‡

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* Memoir No. 69 from the Centre for Advanced Studies in Botany.

‡ Present address: Central Coconut Research Station, Kayangulam (Kerala).

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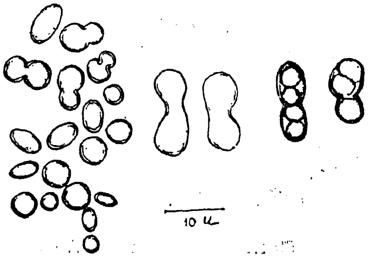
OSMOPHILIC YEASTS IN INDIAN HONEYS

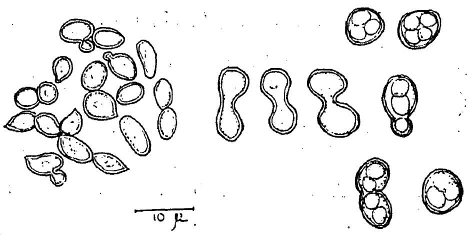
THIS communication reports some preliminary observations on the isolation of osmophilic yeasts from fermented honeys collected from different parts of India.

About 69 honey samples from various parts of Peninsular and Northern India have been examined for osmophilic yeasts along with the pollen analysis of the respective honey samples, which reflects the plant sources visited by bees for pollen and nectar, either from floral or extra-floral nectaries. These nectaries constitute the primary sites for contamination with the osmophilic yeasts.

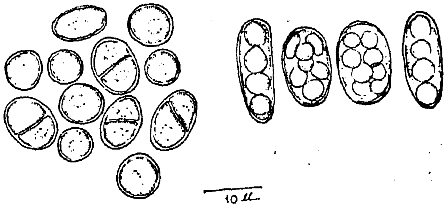
Preliminary cultural studies using different cheap carbohydrate substrates at 60% concentration indicated that the jaggery or molasses could replace honey. Other optimum conditions worked out were pH 6·5 ± 0·2, incubation temperature 30–37° C., and incubation period 4 to 6 days. Samples of fermented honeys were, therefore, directly plated on 60% jaggery-yeast extract-agar medium (pH 6·5) and the plates were incubated at 30° C. and 37° C. for 6 days. The individual colonies were purified by replating. The purified colonies, were studied for their shape, size, texture, colour and other morphological characters.



Saccharomyces mellis.



Saccharomyces rouxii.



Schizosaccharomyces octosporus.

By this method 35 primary isolates were separated, each of these isolates was critically examined for its cytology of vegetative cells, mode of division, sporulation, colony character and other relevant features. On the basis of this data all the isolates could be assembled into ten fixed types assigned to the following genera:

1. *Saccharomyces* with four constant colony-morphotypes; and
2. *Schizosaccharomyces* with six constant colony-morphotypes.

Each of these constant colony-morphotypes was examined for its physiological and biochemical features, according to the procedure prescribed by Lodder and Kreger-van Rij.[1] On the basis of these nutritional, physiological and biochemical criteria, the above ten colony-morphotypes could be tentatively assigned to the following three species:

1. *Saccharomyces mellis* Fabian et Quinet, with one colony-morphotype;
2. *Saccharomyces rouxii* Boutroux, with three colony-morphotypes; and
3. *Schizosaccharomyces octosporus* Beijerinck, with six colony-morphotypes.

It will be seen from the above that in the case of the last two species, several purified constant colony-morphotypes have to be assembled under a common species on the basis of their physiological and biochemical homologies prescribed for their taxonomic characterization at species level. All these variants for the colony-morphotypes are being critically examined for any other biochemical or physiological differences on the basis of which they could be differentiated into subspecies.

The author is indebted to Dr. G. B. Deodikar for assigning this problem, to Dr. R. S. Dhavlikar for guidance on all biochemical aspects and to Prof. M. N. Kamat for his interest. He is thankful to the Central Bee Research Institute for the supply of fermented honey samples; and to the University Grants Commission for providing a Scholarship.

Post-Graduate Research Institute,
Maharashtra Association for Cultivation of Science,
Poona-4, *February* 28, 1969.
M. S. KUMBHOJKAR.

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FOSSOMBRONIA CRISTULA AUST.—A TAXON NEW TO INDIAN FLORA*

THE genus *Fossombronia*—a member of the order Metzgeriales—is represented in the hepatic flora of India by three species: *F. wondraczekii* (Corda) Dum. (= *F. crispata Lindb.*) from Himalaya,[1] *F. indica* St. from Mangalore[2] (South India) and *F. himalayensis* Kash. (= *F. levieri* St.) from Mussoorie.[3]

An examination of our collections of liverworts from South India (during December-January 1965-66) revealed the presence of a fertile *Fossombronia* from Kodaikanal (Bryant Park and lake side road, ca 6845′). The characteristic reticulate spores and the structure of highly reduced elaters of these plants convincingly answer to *F. cristula* Aust.—a taxon rather common in America.[4-7]

This species grows in South India usually in pure and extensive growths or associated with some mosses and grass or sometimes even associated with other species of *Fossombronia* on moist soils and rocks.

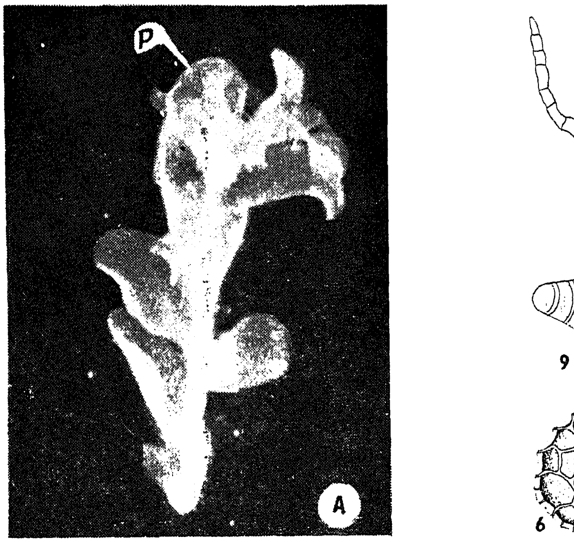
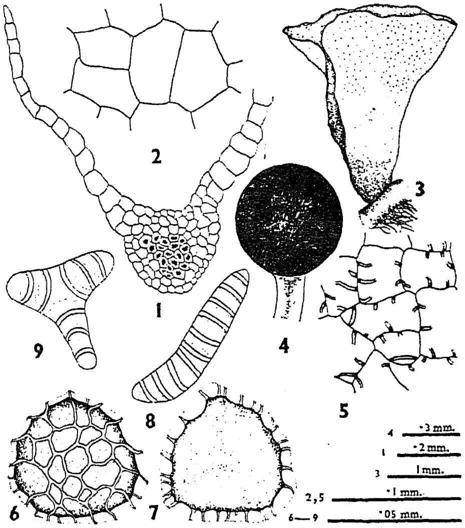


FIG. A A photograph of the plant with dorsal pseudoperianth (*p*) enclosing a young sporophyte, × 8·25.

The plants are green usually forming conspicuous patches. The axis (stem) is 6-10 (–13) mm. long and 2-4 times dichotomously branched. The branches are up to 2–4 mm. long, prostrate or somewhat ascending towards the apex, dorsally more or less flattened and ventrally convex with simple dense vinous purple rhizoids. The internal cells of the axis are thin-walled parenchymatous usually containing fungal hyphæ or mycorrhiza in the central cells as has also been reported in *F. himalayensis*.[3] The leaves are succubous, in two lateral rows, simple, quadrate, anterior margin decurrent and slightly wavy and unistratose except at the base where more than one cell thick (2-3 cells thick). The cells of the leaf are polygonal and thin-walled; apical marginal cells 28·8–86·4 × 14·4–38·4 μ, middle cells 38·4–105·6 × 19·2–57·6 μ and basal marginal cells 48·0–134·4 × 9·6–19·2 μ.

F. cristula is monœcious. The antheridia are globose, shortly stalked, naked, pale-yellow to orange-yellow and are scattered dorsally on the stem or sometimes crowded near the apex at the bases of young leaves. The archegonia are also naked, pink, scattered dorsally on the stem, usually solitary near the bases of the leaves, and sometimes also found along with antheridia near the apex. The pseudoperianth is companulate, plicate, margins slightly undulate or wavy and usually open on one side by means of a longitudinal incision up to the base (Fig. 3). The calyptra is delicate and about 7 cells thick across. The sporophyte is differentiated into a foot, seta and capsule. The seta is short with 7-8 cells in diameter; cells angular and thin-walled. The capsule is spherical (Fig. 4), dark-brown to blackish-brown, rarely exserted and dehiscing irregularly by the separation of the apical portion. The capsule wall is bistratose. The cells of the outer layer are thin-walled and without thickening bands, those of the inner layer, in surface view (Fig. 5), show well-developed incomplete or rarely complete (semiannular) thickening bands. The spores are dark-brown to yellowish-brown, 43·2–57·6



FIGS. 1-9. Fig. 1. Cross-section of the stem and leaves. Fig 2. Leaf cells. Fig. 3. A pseudoperianth enclosing a young sporophyte. Fig 4. A mature capsule with a short seta. Fig. 5. Inner layer cells of the capsule wall with thickening bands. Fig. 6. A spore from distal face Fig. 7. A spore from proximal face. Figs 8-9. Elaters, unbranched and branched.

(60·48) μ in diameter, outer or distal face reticulate, meshes 5-7 across, perispore well developed, spines 12–21 (–25), very prominent and projecting at the margins (Figs. 6, 7). The elaters are highly reduced and inadequately developed, 24–115·2 μ long, 9·6–17·28 μ broad, usually arched, sometimes branched with annular or rarely unispiral thickening bands, spirals less pigmented or pale-yellow (Figs. 8, 9). However, Evans[4] recorded the spore diameter varying from 37–40 μ and elaters to be 28·0–50·0 μ in length and 6–18 μ in breadth for American plants. This clearly suggests that the spores and elaters are comparatively larger in Indian plants although the form and structure invariably remain the same.

The senior author is grateful to the Council of Scientific and Industrial Research, New Delhi, for a project "Studies in the Hepaticæ of South India" under which the present work was completed.

Department of Botany, Ram Udar.
Lucknow University, S. C. Srivastava.
Lucknow, *February* 24, 1969.

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* Contribution from the Department of Botany, University of Lucknow, India, New Series (Bryophyta), No. 60.

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NOTE ON THE HAUSTORIA IN *TAPHRINA MACULANA* BUTLER

In a recent paper published in *Current Science* (August 20, 1968), Chiplonkar[3] has reported the occurrence of haustoria in *Taphrina maculans* Butler parasitic on turmeric (*Curcuma longa* L.) leaves. As in other cases, where the findings are claimed to have been done for the first time, the author has done so without knowledge of the previous work done. The haustorial processes in *T. maculans* have been made out in free-hand sections, which permit little scope for observation. Hence, there is no reference to details of development or their relationship with the host nuclei in the process of parasitism.

Pavgi and Upadhyay[6] reported a detailed cytological account of the process of haustorial development in *T. maculans,* in which the haustorium develops into a lobellate structure after profuse dichotomous branching, approaches and adpresses with the host nucleus, which after an initial enlargement finally shrinks or collapses occasionally. The cytological stages in the development of the ascospore including the chromosome number of the haploid complement have also been published. Development of haustoria in the genus *Taphrina* has been observed earlier in *T. laurencia* Giesenh., *T. osmundæ* Nishida and *T. higginsii,* Mix[4] and is also reported by Butler[1,2] and Mix[5] in *T. maculans*. The statement 'Production of haustoria has not been so far reported in any other species of *Taphrina*' is, therefore, incorrect.

College of Agriculture, M. S. Pavgi.
Banaras Hindu Univ., Rajendra Upadhyay.
Varanasi-5, *January* 28, 1969.

---

1. Butler, E. J., "Leaf spot of turmeric (*Taphrina maculans* sp. nov.)," *Ann. Mycol.*, 1911, **9**, 36.
2. —, *Fungi and Disease in Plants*, Thacker Spink & Co., Calcutta, 1918, p. 547.
3. Chiplonkar Alaka, "Hustoria in *Taphrina maculans* Butler," *Curr. Sci.*, 1968, **37**, 474.
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In my paper published in *Curri Sci.* (August 20, 1968), I have laid no claim to priority in this matter which really belongs to Butler (1911) as clearly made out in the paper.

It is true that the writer published her account on the occurrence of haustoria based on free-hand sections although subsequent work done by her in fixed microtomed sections has confirmed in general the process of development described by her and earlier by Pavgi and Upadhyay (1967). Unfortunately the paper by Pavgi and Upadhyay having been published in a Japanese Journal was not readily available to the writer for consultation until a copy was sent to her by Dr. Pavgi sometime in September 1968 (Personal communication).

My statement in the above paper regarding the production of specialised haustoria not having been reported in any other species of *Taphrina* besides *T. maculans* is, therefore, correct. Unfortunately, the word "specialised' has been omitted in the final printing, which has led to misunderstanding. This is regretable,

M.A.C.S. Labs., Alaka Chiplonkar,
Poona-4 (India),

REVIEWS AND NOTICES OF BOOKS

Introduction to Modern Algebraic Concepts. By Larsen. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. 143. Price $ 46.00.

This book is intended for a one-semester course. There is sufficient material for an introductory course in modern algebra or a course in the development of the real number system from Peano's Postulates. The book is especially readable for beginners. Furthermore, the level of the material makes the book suitable for a beginning course for either mathematics majors or prospective teachers.

The book commences with an exposition of the fundamental concepts necessary for understanding the remainder of the material in the volume: sets, mappings, equivalence relations, and binary operations. A short section on symbolic logic is also included. The following chapters are concerned respectively with Groups; Rings; The Integers; Integral Domains and Fields; Polynomials; and The Real Number System. C. V. R.

Annual Review of Physiology (Vol. 31). Edited by Victor E. Hall. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1969. Pp. ix + 787. Price $ 8.50 in U.S.A. and $ 9.00 elsewhere.

The following are the contents of the volume: A Half Century in Science and Society, by Maurice B. Visscher; Growth and Differentiation, *with special emphasis on the central nervous systems*, by Sten Skoglund; Comparative Aspects of Muscle, by Graham Hoyle; Exercise, *Including Weightlessness*, by Lars-Goran Ekelund; Kidney, Water, and Electrolytes, by E. E. Windhager; Respiration, by Norman C. Staub; Digestion: Motor Function, by E. E. Daniel; Liver: Functional Interactions within the Intact Animal, by William C. Shoemaker and David H. Elwyn; Blood Clotting Mechanisms: Three Basic Reactions, by Walter H. Seegers; Overall Circulatory Regulation, by Kiichi Sagawa; Hemodynamics, by Paul C. Johnson; The Endocrine Function of the Pancreas, by Lawrence A. Frohman; Neuroendocrine Aspects of Mammalian Reproduction, by John W. Everett; Somatic Sensation, by Ian Darian-Smith; Motor Mechanisms of the CNS: Cerebrocerebellar Interrelations, by E. V. Evarts and W. T. Thach; Neurophysiology of Vision, by Otto Creutzfeldt and Bert Sakmann; Comparative Physiology of Hearing, by Alan D. Grinnell; Biological Membranes: The Physical Basis of Ion and Non-electrolyte Selectivity, by Jared M. Diamond and Ernest M. Wright; Cardiac Muscle: Activation and Contraction, by Edmund H. Sonnenblick and Allan C. Stam, Jr.; and Chronobiology, by Franz Halberg.

C. V. R.

Publications of the Geological Society of America, Inc., P.O. Box 1719, Boulder, Colorado 80302:

1. **Coastal Dunes of California.** By W. S. Cooper. Pp. 131. Price $ 8.50 (1967).
2. **Saline Deposits.** By R. B. Mattox. Pp. 701. Price $ 19 (1968).
3. **Abstracts for 1966.** Pp. 485. Price $ 7.50 (1968).

A project on the geomorphic history of the coastal sand-dunes to cover the entire Pacific coast of the United States was undertaken by the author William S. Cooper about two decades ago. The first part of this study was published in 1958 as Memoir 72 of the GSA. It covered the coastal areas of Washington and Oregon. The present work, which forms Memoir 104 of the GSA, completes the investigation. It deals with the coastal dunes of California; five localities in northern Baja California are also included.

Vegetation is a factor in dune development wherever climate permits plant growth. In the present project study of plant life has been carried on parallel to that of the geomorphic features. The memoir contains 4 maps and 11 plates.

Saline Deposits, which forms Special Paper No. 88 of the GSA, is a Symposium based on papers from the International Conference on Saline Deposits, Houston, Texas, held in November 1962. The Conference included field studies of three areas underlain by extensive salt deposits. These included the Paradox Basin of Colorado and Utah, the Permian Basin field area of Texas and New Mexico, and the

Gulf Coast salt dune area. These studies form Part I of the monograph. Part II on Stratigraphy and Structural Geology contains 17 papers and abstracts of additional papers. Part III on Geochemistry contains 4 papers and additional abstracts. Part IV on Physical Properties contains 5 papers. Discussion of papers in the various sections is included in Part V under Work Session Reports.

Abstracts for 1966, which is the Special Paper No. 101 of the GSA, contains the abstracts of papers submitted for six meetings in 1966 with which the Society was associated, namely, San Francisco, November 14–16; Philadelphia, February 10–12; Reno, Nevada, April 6–9; Athens, Georgia, April 13–16; Las Vegas, Nevada, May 11–14; Washington D.C., December 26–31. A. S. G.

Tables of Spectral Lines of Neutral and Ionized Atoms. By A. R. Striganov and N. S. Sventitskii. Translated from Russian. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011, U.S.A.). Pp. xi + 899. Price $40.00.

Optical atomic spectroscopy finds ever-widening application in various fields of Physics and Technology. Spectroscopic methods have acquired great importance for the determination of the most important parameters of plasma in discharge tubes, in plasma apparatus, and in ion sources. The development of quantum generators is closely linked with the utilization of the results of optical spectroscopy. Hence, it has become necessary for investigators in these disciplines to have easy access to data on the spectra of atoms and their ions. The publication under review supplies this need.

The volume gives a complete coverage of the emission spectra of 22 of the elements with which plasma physicists have mostly to deal. These include all gaseous elements Hydrogen (including deuterium and tritium), Helium, Neon, Argon, Krypton and Xenon, Nitrogen, Oxygen, Chlorine and Fluorine, the alkali metals Lithium, Sodium, Potassium and Cæsium, and Carbon, Magnesium, Aluminium, Silicon, Calcium, Titanium, Iron and Copper.

There are over 30,000 lines on the IR, visible, near-UV, and far-UV regions of the spectra. For each element in addition to the spectra of the neutral atom, the spectra of several of its successive stages of ions are also given. Against each spectral line the wavelength, intensity and classification are given. This is an indispensable reference work for spectroscopists and plasma physicists. A. S. G.

Fundamental Thermodynamics. By G. Weinreich. (Addison-Wesley Publishing Company). Pp. 231.

The book is designed for a first-year graduate course on classical thermodynamics. The presentation is traditional, and at the end of each chapter there are a number of exercises and problems. A. S. G.

Experiments in Microbial Genetics. Edited by R. C. Clowes and W. Hayes. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX1 4HB, England), 1968. Pp. 244. Price 42 *sh.*

This is an excellent laboratory manual for teaching microbial genetics to a class of students. The experiments are based on annual summer school courses presented by the members of the staff of the Medical Research Council's Microbial Genetics Research Unit at Hammersmith Hospital, London, over the years 1960–64. The manual contains 37 key experiments on the subject. Each experiment is described under the following heads: Intention, Background, Requirements, Conclusions and References. Appendices give details of special media and techniques, the geneology and availability of genetically marked microbial strains, including fungi, bacteria and bacteriophages.

The experiments being illustrative of most of the important genetical principles, this laboratory manual is indispensable for teachers and students of molecular biology. A. S. G.

Books Received

IBP Hand Book No. 7—A Practical Guide to the Study of the Productivity of Large Herbivores. By F. B. Golley and H. K. Buechner. (Blackwell Scientific Publishers, 5, Alfred Street, Oxford), 1968. Pp. vii + 308. Price 40 *sh.*

The Chemical Bond. By Linus Pauling. (Oxford University Press, Mount Road, Madras-2), 1967. Pp. xi + 267. Price 22 *sh.* 6 *d.* or Rs. 20·25.

Technical Communication No. 39 of the Commonwealth Bureau of Helminthology—Plant Nematology in Africa South of the Sahara. By P. R. Thomas and C. E. Taylor. (Commonwealth Agricultural Bureaux, Farnham Royal, Buck, England), 1968. Pp. 83. Price 60 *sh.*

1225-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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Current Science is the Premier Science Fortnightly of India published by the Current Science Association, Bangalore, and issued on the 5th and 20th of each month. All material intended for publication in CURRENT SCIENCE (Articles not exceeding 2,000 words and Letters not exceeding 500 words, with brief abstracts and minimum number of illustrations to stand column size reduction) and books for review should be addressed to the Editor, *Current Science,* Raman Research Institute, Bangalore-6.

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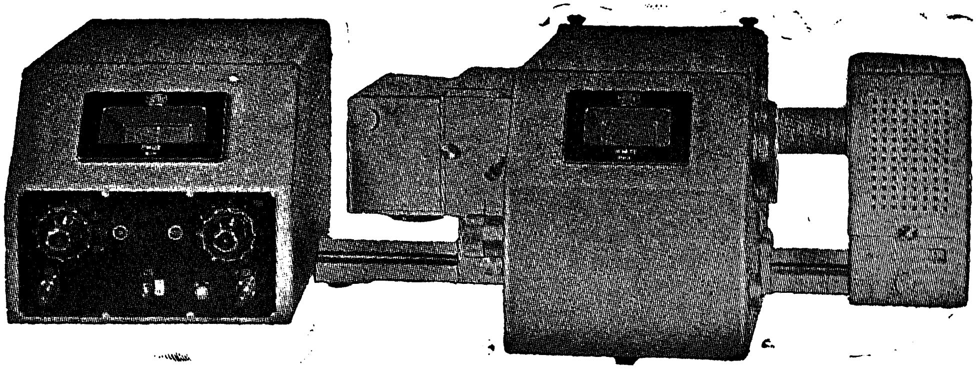

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APPLICATION OF STEREO NUMBERS IN SUGAR CHEMISTRY*

S. NEELAKANTAN

Department of Chemistry, Madurai University, Madurai-2

MOST students of organic chemistry comprehend the fact that there are sixteen (2^4) stereoisomers possible for an aldohexose containing four asymmetric carbon atoms and that they can be represented by eight pairs of enantiomers each of which is composed of one D- and its corresponding L-isomer. However, students are not familiar with quick naming of these eight pairs of isomers. As an aid for remembering the names of the eight D-aldohexoses in relation to their stereochemistry, Fieser and Fieser[1] have suggested the following mnemonic: "*All altruists gladly make gum in gallon tanks*". The use of this mnemonic finds a place also in a book on carbohydrates.[2] Corresponding to the portions italicised in the above mnemonic, the names of the aldohexoses are allose, altrose, glucose, mannose, gulose, idose, galactose and talose. For constructing the outline projection formulæ of the eight D-aldohexoses, one has to perform the following operation: The names of the eight sugars in the order in which they come according to the mnemonic are written one after the other in a line and above each is written –CH_2OH. Then for C-5 (the last asymmetric carbon atom), the OH group is written to the right of the vertical chain of the projection formula for all the eight arrangements. For C-4, the OH group is represented to the right for the first four formulæ and to the left for the rest four. For C-3, the OH group is written to the right for the first two, then to the left for the next two, again to the right for the subsequent two and finally to the left for the last two formulæ. The configuration of C-2 is indicated in such a way that the first formula has the OH to the right, the second to the left, the third to the right and so on. The result is as indicated in Chart I. From this representation, the configurations of the eight L-aldohexoses also follow (*see* Chart I).

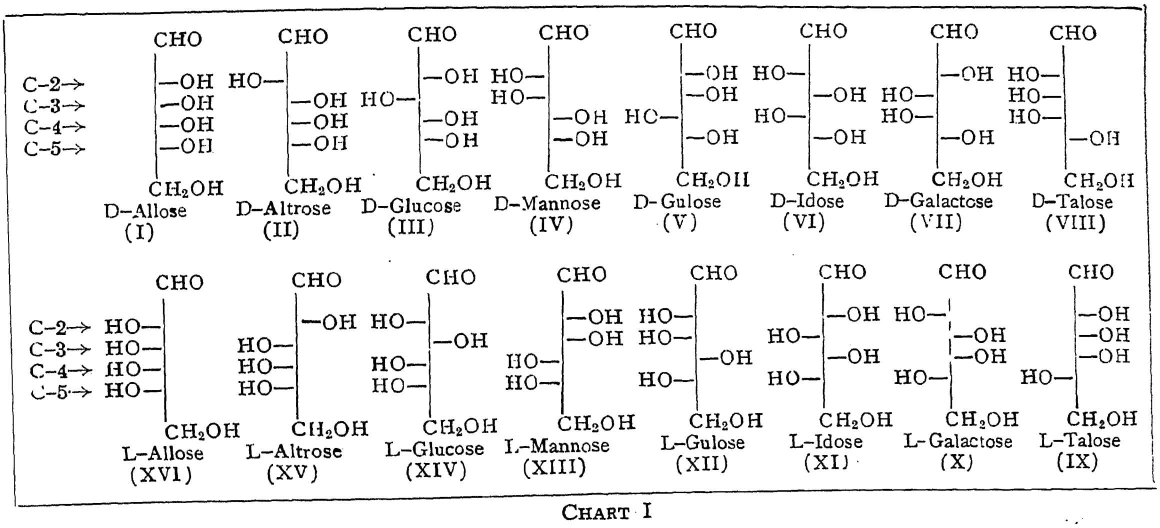

CHART I

While the above method of representation is convenient when the projection formulæ of all the eight possibilities of D-aldohexoses are to be represented using the mnemonic, it is not easy if one has to quickly visualize the stereochemistry of a less familiar sugar like L-idose or D-talose. It will usually be necessary to write the projection formulæ of all the eight D-sugars and then pick up the appropriate ones.

---

* Presented at the Summer Institute in Chemistry held at Madurai during May–June 1969.

In the present paper, a convenient method for quickly representing the stereochemistry of not only the eight D-aldohexoses but of the enantiomeric L-sugars also is discussed. For this purpose, the method of *stereo numbers* forms the basis. Feldman[3] has introduced the idea of stereo numbers for designating the stereoisomers in the fields of steroids, higher sugars, etc. The main basis in this notation is the binary system of arithmetic which uses only two symbols in the code. The binary system has been used by Rosenblatt[4] as a basis for the panoramic approach to the proof of the configurations of aldohexoses. In Rosenblatt's paper, four criteria have been chosen as questions and the answers to these questions are allotted either number 1 or number 0 depending on whether the answer is 'yes' or 'no'. It may be noted from Table I (*vide infra*) that the four criteria used by Rosenblatt[4] do not lead to any systematic representation.

For the present discussion, the direction in which the OH group, attached to the asymmetric carbon atom, is oriented in the projection formula decides the number. Thus if the OH group is projected to the right, it is allotted number 1 and if to the left, it has the number 0. In the final binary code number, the first number from the left-hand side corresponds to the orientation of the fifth carbon atom (last of the asymmetric carbon atoms), the next number which follows the first number corresponds to the orientation of the OH group of C-4 atom and so on. On this basis, the binary code number of D-allose (I) is 1111 and for D-altrose (II) it is 1110. In this way we arrive at the binary numbers for all the sixteen aldohexoses which are given in Table I. Each of the binary code numbers can be transformed into its respective decimal equivalent which is given in column 3 of Table I. The decimal equivalent number of an aldohexose is known as its *stereo number*.

As already mentioned, Rosenblatt[4] made use of the binary system as a basis for the panoramic approach to the proof of configuration of aldohexoses. But the decimal equivalent of the binary code number derived by Rosenblatt based on four other criteria for each of the aldohexoses does not follow any order (*see* column 5 of Table I) unlike the present approach (*see* column 3 of Table I).

Another method[3] of expressing binary numbers in a shorter form is the use of the equivalent octal numbers.† If the octal system is used in the present case, the binary numbers of the sixteen aldohexoses turn out to be as indicated in column 4 of Table I. Though there is a certain degree of order in the octal system also when we go from D-allose to D-talose and then from L-talose to L-allose, the decimal system is better since on going from D-allose through D-talose and then through L-talose to L-allose, the decimal equivalent number (stereo number) goes on decreasing from 15 to 0.

TABLE I

Name of sugar (1)	Binary code number (2)	Decimal equivalent of binary code number (Stereo number) (3)	Octal equivalent of binary code number (4)	Decimal equivalent of binary code number based on Rosenblatt's procedure[4] (5)
D-Allose (I) ..	1111	15	17	2
D-Altrose (II) ..	1110	14	16	8
D-Glucose (III) ..	1101	13	15	11
D-Mannose (IV) ..	1100	12	14	15
D-Gulose (V) ..	1011	11	13	10
D-Idose (VI) ..	1010	10	12	14
D-Galactose (VII) ..	1001	9	11	3
D-Talose (VIII) ..	1000	8	10	9
L-Talose (IX) ..	0111	7	7	9
L-Galactose (X) ..	0110	6	6	3
L-Idose (XI) ..	0101	5	5	14
L-Gulose (XII) ..	0100	4	4	10
L-Mannose (XIII) ..	0011	3	3	15
L-Glucose (XIV) ..	0010	2	2	11
L-Altrose (XV) ..	0001	1	1	8
L-Allose (XVI) ..	0000	0	0	2

The sum of the stereo numbers of two enantiomeric compounds is equal to $2^n - 1$ where n is the number of asymmetric carbon atoms in the molecule. Thus the sum of stereo numbers of members of a pair of enantiomeric aldohexoses is $2^4 - 1 = 15$, based on the decimal equivalent representation of the binary system of arithmetic.

---

† In the octal system, the numbers run from 0 to 7 as shown below :

Binary number ..	000	001	010	011	100	101	110	111
Octal number ..	0	1	2	3	4	5	6	7

To get the octal number of a binary number like 101001, the binary number is broken into groups of three from the right. Thus the equivalent octal number of the above binary number is 51 (*i.e.*, 101/5, 001/1). Similarly, the octal number of 01011 is 13.

The main advantage of the present approach is the ease with which one can write the Fischer projection formula of any aldohexose if the mnemonic suggested by Fieser and Fieser[1] is kept in mind. As an illustration, the stereochemistry of L-gulose can easily be represented as (XII) by the following steps. The stereo number of D-gulose is 11 since D-allose has this number as 15 and D-gulose is fifth in the order starting from D-allose as the first according to the mnemonic. Hence, the stereo number of L-gulose is $15 - 11 = 4$. On converting the decimal equivalent 4 into the binary number, it will be 0100 which means that the hydroxyl groups of the C-5, C-3 and C-2 are projected to the left and that of C-4 to the right. Similarly, one can work out the stereochemical representation of L-glucose which corresponds to (XIV) since the binary code number of L-glucose is 0010, its stereo number being 2.

ACKNOWLEDGEMENT

The author's thanks are due to Professor M. Venkataraman, Head of the Department of Mathematics, Madurai University, for the useful discussions on this paper.

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COSMIC RAY STUDIES*

THERE have been, over the recent past, spectacular developments in various areas of astronomy, astrophysics and cosmology such as the discovery of quasars, of pulsars, of the apparently universal radiation in the microwave and infrared regions, of the existence of violent explosive phenomena in the universe, problems of nucleosynthesis, and a great deal else that cannot be compressed into a few words here. It has become increasingly clear that the detailed features of cosmic ray phenomena are closely tied up with the various astrophysical parameters and processes, particularly those concerning these new discoveries.

This book reproduces the proceedings of a Colloquium which was organised and held in Bombay from November 11 to 16, 1968, by the Tata Institute of Fundamental Research, Bombay, primarily to identify, and to focus attention on, the important connections and overlapping areas of interest created as a result of recent advances in cosmic ray research on the one hand, and spectacular developments in astronomy, astrophysics and cosmology on the other. In the Colloquium, about equal working time was devoted to invited talks and panel discussions.

This book includes all the invited talks and reports of the panel discussions.

The titles of the invited talks and their respective speakers are: 1. Abundances of the Elements, by A. G. W. Cameron; 2. Nucleosynthesis, by W. A. Fowler; 3. Composition of Cosmic Rays, by S. Biswas; 4. Cosmic Ray Nuclei of Charge Greater than 20, by D. Lal; 5. On the Propagation of Cosmic Rays, by Yash Pal; 6. X-Ray and Gamma-Ray Astronomy, by B. Rossi; 7. Background X-rays and Gamma-Rays—Interpretations, by S. Hayakawa; 8. Interstellar Matter, by H. C. van de Hulst; 9. Radio Continuum, by J. R. Shakeshaft; 10. The Microwave Background Radiation, by W. H. McCrea; 11. Cosmic Rays at Energies beyond 10^{12} eV, by B. V. Sreekantan; 12. Cosmic Ray Electrons, by R. R. Daniel; 13. Dynamics of the Galactic Disc, by E. N. Parker; 14. Quasars—Observational, by M. K. V. Bappu; 15. Quasars—Interpretative, by W. H. McCrea; 16. Observations of Pulsars, by J. R. Shakeshaft; 17. Solar Neutrinos, by W. A. Fowler; and 18. Radio Source Counts, by J. R. Shakeshaft.

The subjects dealt with under panel discussions are: 1. Nuclear Abundances; 2. Spectrum and Composition; 3. X-rays, Gamma-Rays and Electrons; 4. Cosmic Ray Origin; 5. Problem of Helium Abundance; 6. Pulsars; 7. Neutrinos in Astrophysics; and 8. Cosmology.

This volume will be of great interest and value to all those working in this field.

C. V. R.

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* *Cosmic Ray Studies* in relation to recent developments in Astronomy and Astrophysics, Edited by R. R. Daniel, P. J. Lavakare and S. Ramadurai. (Published by the Tata Institute of Fundamental Research, Bombay, India), 1969. Pp. 374. Price: to Colloquium Participants: Rs. 10 and to all others: Rs. 50 or $ 7.00 or £ 3-0 *sh.*-0 *d.*

SIGNIFICANCE OF BORON IN THE METABOLISM OF COTTON PLANT

H. S. SAINI, H. M. DANI, I. S. ALLAG AND K. SAREEN
Department of Biochemistry, Panjab University, Chandigarh

ABSTRACT

Cotton plants were sprayed with 0·125% and 0·250% boric acid solutions at intervals of nine, eleven, fourteen and eighteen weeks after sowing. Sprays of 0·125% boric acid were found to be optimum for significantly increasing the number of leaves and flowers, the RNA content of leaves at full blooming stage and the total nitrogen content of kernels, as compared to the control plants (untreated). The authors have discussed various biochemical possibilities for this promotive effect of boron on these morphological parameters.

INTRODUCTION

BORON occurs in most soils in extremely small quantities ranging generally from 20 ppm to 200 ppm. It does not normally occur in toxic quantities in most aerable soils unless it has been applied in excessive amounts either to the soil or through sprays. A critical survey of literature reveals that even when soils show no distinct deficiency symptoms of any essential element, plants do respond to some of them. Research work, conducted at the Indian Agricultural Research Institute, New Delhi, from 1954-1961, has shown that out of all the micronutrients only boron promotes the growth and increases the yield of crops (Dani).[1]

It has been pointed out by Holly and Duline[2] that the dose of boron sufficient for vegetative growth of cotton plant may fall deficient at the flowering stage, as it is necessary for flower-bud development. A number of investigators[3,4] have suggested that boron might play some important role in the protein metabolism of the cotton, plant, while certain other authors[5–7] have hypothesized its possible role in the metabolism of plant nucleic acids.

The present studies were, therefore, undertaken to explain the observed morphological changes on the basis of explicit biochemical reasoning and to find out a possible explanation for the higher needs of boron by the cotton plant at the flowering stage.

MATERIALS AND METHODS

Cotton (*Gossypium hirsutum* L.), variety 320 F, was grown on a uniformly fertile soil. Seeds were sown in straight lines, with an appropriate distance of 1½′ between the rows and 6″ to 8″ from seed to seed. Proper irrigation of the field was done at an interval of one month in the first instance and at adequate intervals thereafter, depending upon rainfall.

Eighteen healthy plants of almost equal height were selected from the field and randomly divided into three groups, each consisting of six plants. Two groups were put under 0·125 and 0·250% boric acid treatments and the third group was left untreated (control). Boric acid solutions were sprayed at intervals of nine, eleven, fourteen and eighteen weeks after sowing.

Number of leaves and flowers on each plant was recorded separately, just before each spray was to be applied. Samples of stems and leaves for RNA estimation were collected after one week of the final spray at the full blooming stage. Ripened seeds were collected for total nitrogen determination.

RNA contents of stems and leaves were determined by modified method of Schmidt-Thannhauser as detailed by Glick.[8] Total nitrogen in cotton-seeds was estimated by microkjeldahl method as described in A.O.A.C.[9] About thirty seeds were randomly picked from each plant their seedcoats removed and kernels crushed to fine powder for total nitrogen estimation.

RESULTS AND DISCUSSION

Effect on RNA Content.—A critical evaluation of the data pertaining to number of leaves (Fig. 1) shows that 0·125% boric acid sprays produced a highly significant effect, while 0·250% boric acid sprays suppressed the number of leaves without any significant inhibitory effect.

Table I represents the mean RNA contents of leaves and stems of cotton plants at full blooming stage. Both in the case of the leaves and the stems there was a significant decrease in the RNA content of 0·250% boric acid-treated plants, whereas 0·125% boric acid spray showed highly significant increase in the content of the leaf RNA only. The lower concentration of boric acid did not increase the

RNA content of stems, probably due to the higher utilization of the absorbed boron by the leaf tissues themselves. 0·250% boric acid seemed to be toxic to the cotton plant and therefore suppressed RNA biosynthesis. A highly significant increase in the RNA content of 0·125% boric acid-sprayed plants very clearly showed that the element was unequivocally participating in the biosynthesis of ribonucleic acids. Further investigations in progress in our laboratories are expected to decipher this aspect of the problem.

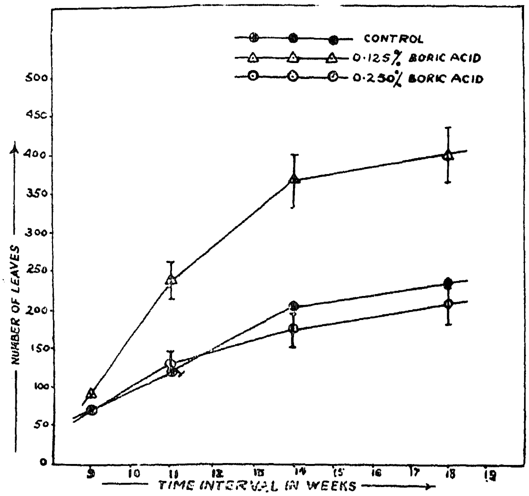

FIG. 1. Effect of boric acid sprays on the number of leaves of cotton plant. Each value represents a mean of six replications. Standard errors of the means are indicated by vertical lines.

TABLE I

*Statistical evaluation of the effects of boric acid treatment on the RNA content of leaves and stems, and the total nitrogen content of the kernels (seeds) in cotton plant**

Treatment	RNA (μg./gm. in dried tissue)		Nitrogen percentage
	Leaves	Stems	Kernels
1. Control	12·96	11·33	6·46
2. Boric acid (0·125%)	21·58	12·31	8·12
S.D. ±	2·072	1·380	0·176
t value†	7·20	1·22	16·30
3. Boric acid (0·250%)	10·47	10·16	7·04
S.D. ±	0·318	0·199	0·167
t value†	13·50	10·10	6·00

* Each reading represents a mean of six replications.

† Significant at 5% level when t_{10} as compared to control ⩾ 2·23 highly significant at 1% level when t_{10} as compared to control ⩾ 3·17.

Effect on Floral Initiation.—Our results show a highly significant increase in the number of flowers in the case of 0·125% boric acid-treated plants after two sprays (Fig. 2). The results became statistically still more significant after third spray. Boric acid sprays of 0·250% concentration did not show any significant increase in the number of flowers, probably due to some toxic effect on the conversion of leaf-buds to flower-buds.

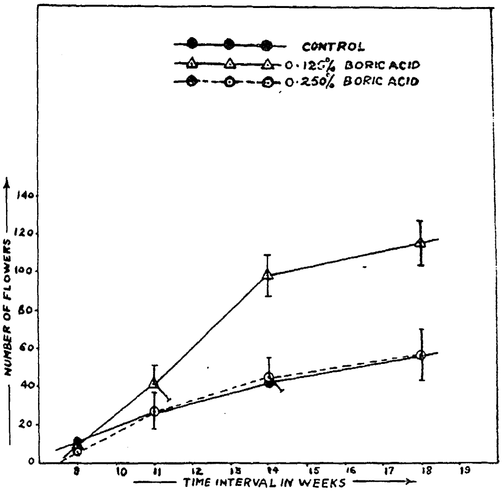

FIG. 2. Effect of boric acid sprays on the number of flowers of cotton plant. Each value represents a mean of six replications. Standard errors of the means are indicated by vertical lines.

The present authors suggest that the following two mechanisms might possibly explain the above effect of boron in increasing the number of flowers in cotton plant:—

1. Pineapple plant is the only known example in which ethylene (or acetylene) functions as a flowering hormone or a stimulant for the formation of the hormone. Boron might be playing a role in the cotton plant analogous to that of ethylene (or acetylene) in the pineapple plant, thus justifying its higher requirement at the flowering stage. Our observation regarding the inhibitory effect of the higher concentration of boric acid (0·250%) on floral initiation in cotton plant resembles the similar effect of high concentration of ethylene on the pineapple plant. It thus seems that ethylene and boron might be analogous growth regulators in pineapple and cotton plants respectively.

2. The effect of boron in significantly increasing the number of flowers in cotton plant might also be explained on the basis of

its action on auxin concentration. It is known that in the majority of plant species the application of indole acetic acid or other active auxins to the leaves delays the appearance of flower-buds, and in some cases its repeated and daily application inhibits flowering for a long time.

Shkol'nik and Maevskaya[5] have pointed out that the effect of boron on the synthesis of growth substances need exhaustive studies. It has been recently suggested by Coke and Whittington[10] that boron-deficient tissues suffer from an excessive auxin concentration either because the element is necessary for some growth processes, such as cell-wall formation or nucleic acid synthesis, which, when impaired, result in the accumulation of auxins, or because the indole acetic acid-oxidation system is affected by phenolic inhibitors which boron normally activates by complex formation.

In view of the above facts, it is possible that high boron levels needed at the flowering stage in cotton plant may be interfering either with the biosynthesis of indole acetic acid or by activating indole acetic acid-oxidation system. The outcome of any of these possibilities will lead to accelerated flowering due to suppressive effect of boron on indole acetic acid activation. The elucidation of the precise mechanism involved in this process at the molecular level is in progress in our laboratories.

Effect on Nitrogen (Protein) Content.—It is well known that, commencing from the flowering and fertilization processes (Doby and Füleky),[11] the leaves continually transport protein to the seed. The samples of leaf and stem tissues for the estimation of RNA were therefore taken at the full blooming stage of the cotton plant. Our main objective in doing so was to investigate whether the effect of boron on RNA concentration of leaves was in any way related to the increase in the total nitrogen content of the seeds, which, in turn, is derived to a large extent from the leaves in the form of soluble peptides and proteins.

It is interesting to note from our observations (Table I) that the total nitrogen percentage is significantly increased in the case of seeds obtained from plants treated with 0·125 and 0·250% boric acid, which means that the overall nitrogen content of the cotton-seeds is markedly increased by the application of boron. The element seems to play a multifold role in nitrogen turnover of the cotton plant either by affecting RNA or protein biosynthesis. Its action on increasing the mobility of labile nitrogen compounds is clear from a highly significant accumulation of nitrogen in the seeds of 0·250% boric acid-treated plants, even when this high concentration has proved to be toxic and suppressive for all other parameters studied.

CONCLUSION

Our observations emphatically suggest that intermittent sprays (3-4 weeks) of 0·125% boric acid solution on cotton plants, about five to six weeks old, will produce remarkably beneficial effects in promoting the number of leaves and flowers, which, in turn, might go a long way to enhance the yield of cotton. It should be applicable to all types of soils which do not contain toxic concentrations of boron. It is hypothesized that boron helps floral initiation of cotton plants, probably by suppressing indole acetic acid activity, or by stimulating the formation of flowering hormone. It also increases the percentage of total nitrogen of kernels, improving thereby the nutritive value of cotton-seed. This effect, in our view, is considered to be controlled through a direct or indirect effect of boron on protein biosynthesis.

ACKNOWLEDGEMENT

The authors are highly indebted to the University Grants Commission for providing the financial assistance to the Plant Biochemistry Section of the Department of Biochemistry, Panjab University, Chandigarh, for carrying out this research work.

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EFFECT OF GIBBERELLIC ACID ON *LAUNAEA ASPLENIFOLIA*

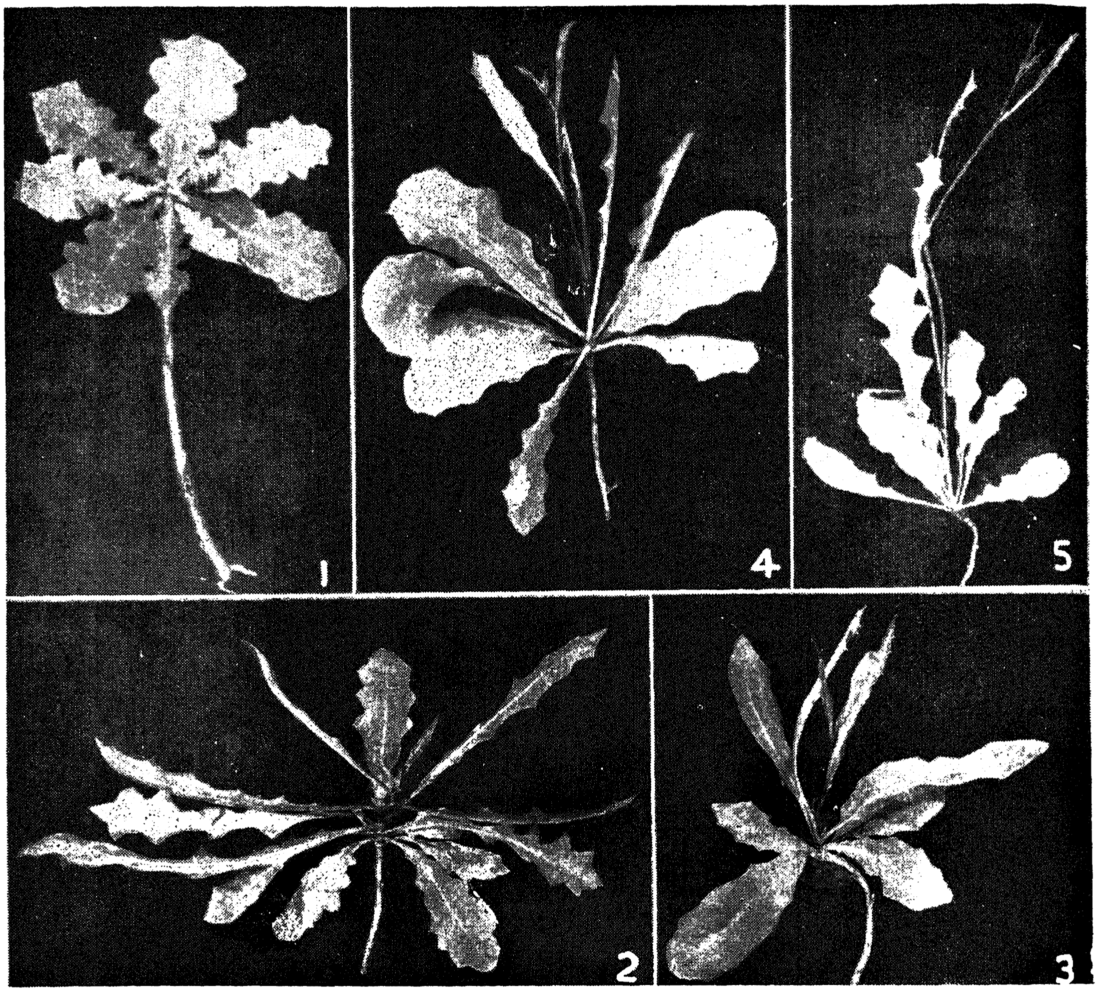
HARDEV SINGH AND K. K. PUSHPAVATHY
Department of Botany, University of Delhi, Delhi-7

OBLIGATE fungal parasites such as species of *Puccinia* have been reported to interfere with auxin metabolism and alter the stem growth in some host plants (*see* Shaw[14]). In our studies, we have observed that the infected individuals of *Launœa asplenifolia* (showing pycnia and æcia of *Puccinia butleri*) grow erect whereas the healthy plants grow as rosettes. Gibberellins are known to induce bolting (stem elongation followed by flowering) in rosette plants (Lang[7,8]; *see also* Johri and Varner[4]). This prompted us to find out whether or not an application of gibberellic acid (GA_3) could duplicate the effect of pathogen on the host.

Fifty plants (raised from seeds) that were nearly 2-month-old were selected for GA_3 treatment. At the time of treatment the plants were rosettes. Each rosette comprised a condensed stem and 8-12 leaves. Ten ml. of stock solution (1 mg./ml.) was prepared and a drop (0·01 ml.) of surfactant Tween-80 added to it. All dilutions were prepared from this stock solution. GA_3 was used at 4 concentrations (5, 10, 20 and 30 μg./0·1 ml.). For each concentration 10 plants were treated. In all, 10 plants were maintained as untreated controls. The shoot tip of each plant was covered with a wad of cotton. In untreated controls, the cotton was wetted with 0·1 ml. of distilled water mixed with the surfactant. In the plants to be treated the cotton wad was wetted with 0·1 ml. of GA_3 solution of the desired concentration. The treatment was repeated every third day up to 13 days. Thus, each plant received 0, 25, 50, 100 or 150 μg. GA_3. Both control and treated plants were periodically observed up to 38 days from the start of the experiment. Until 10 days after the last application of GA_3, there was no significant change in the appearance of plants. Thereafter, in the treated plants, the shoot tip started elongating. The control plants remained unchanged (Fig. 1). Twenty-eight days from the start of the experiment, plants which had received 25 μg. GA_3 developed a shoot which showed rather short internodes and looked like a sympodium (Fig. 2). The plants treated with 50 μg. GA_3 also developed an erect stem, but the internodes remained short (internode length 0·7 cm.; Fig. 3). At 100 μg, GA_3 induced the formation of a central erect stem with long internodes (internode length 1·2 cm.; Fig. 4). The shoot apex of plants treated with 150 μg. GA_3 produced an erect and slender shoot (internode length ca 3 cm.; Fig. 5). But after about a week, the shoot wilted. Thus, 150 μg. GA_3 appears toxic to stem growth. The quantity of GA_3 most effective in inducing stem elongation was 100 μg. The stem elongation in GA_3-treated plants was nearly the same as the rust-infected individuals.

Infection by microbial pathogens is known to cause abnormalities of growth in many flowering plants. One of the common effects of fungal infection is an exaggerated elongation of internodes (Buller;[3] Sequeira;[13] Philipson[10]). Pilet[11,12] demonstrated increased IAA in some of the rust-infected species in which the disease is characterized by stem elongation. However, according to Brian,[2] "the symptoms are much more reminiscent of gibberellin excess....". Shaw[14] pointed out that "in view of the growth-promoting effects of gibberellins.... it would be unwise to assume that indole auxins are necessarily connected with the effect of parasites on the growth of their hosts and increase in the indoleacetic acid contents of the infected tissue may be coincidental; it would however be equally unwise to ignore such changes on these grounds....".

Bailiss and Wilson[1] demonstrated an unusually high level of endogenous gibberellins in *Cirsium arvense* infected with *Puccinia punctiformis*. In our investigations on *Launœa*, GA_3 application elicited an effect similar to that by rust infection. This may have been caused by GA_3 itself or by auxins such as IAA whose level is known to increase following the application of GA^3 (*see* Philips *et al.*;[9] Kuraishi and Muir[5,6]). This permits the conclusion, although tentative, that the plants of *Launœa* infected with *Puccinia butleri* are rich in gibberellin-like or auxinic substance(s) which induce(s) an erect and elongated growth of shoot.



FIGS. 1–5. Fig. 1. Control plant bearing a rosette of leaves, × 1·5. Figs. 2–3. Plants which received 25 and 50 μg. GA_3; in both plants the tip has grown into a shoot which possesses short internodes; in Fig. 2 the stem appears zig-zag, natural size. Figs. 4–5. Plants treated with 100 and 150 μg GA_3; the newly developed shoots have longer internodes as compared to Fig. 3. Fig. 4 × 1; Fig. 5 × 0·75.

ACKNOWLEDGEMENTS

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LETTERS TO THE EDITOR

ON B-X SYSTEM OF SiCl MOLECULE

The emission spectrum of the SiCl molecule was first observed by Jevons[1] and three systems were reported in the regions 3100–2800 Å, 2600–2350 Å and 2350–2220 Å.

The vibrational constants of the upper state of the (B-X) system, lying in the region 3100–2800 Å, were not determined accurately, as the assignments of (2, 0) and (3, 0) bands were doubtful. Later, Verma[2] reported the rotational analysis of these doubtful bands and found that they belonged to a new $A^2\Delta$–$X^2\Pi$ transition.

To obtain the vibrational constants of the $B(^2\Sigma^+)$ state more accurately, system has been studied in the presence of argon, and new bands at (2869·8 Å, 2852·3 Å) (2913·2 Å, 2895·7 Å) and (—, 2797·8 Å) are recorded. The wavelengths given in brackets correspond to the sub-heads of the system $^2\Sigma^+$–$^2\Pi$. Their assignments as (2, 1), (2, 2) and (3, 1) have led to a better determination of the vibrational constants of the upper state. The observed isotopic shifts, *i.e.*, 1·1 cm.⁻¹ and 9·5 cm.⁻¹ for (0, 0) and (1, 0) bands have also been explained with these modified vibrational constants. The P_2 heads are fairly well represented by:

$$\nu = \left.\begin{matrix}34102\cdot1\\33895\cdot2\end{matrix}\right\} + (708\cdot1\,u' - 4\cdot2\,u'^2) - (534\cdot8\,u'' - 2\cdot1\,u''^2)$$

where $u = v + \frac{1}{2}$.

The rotational analysis of (1, 0), (0, 0) and (0, 1) bands of the same system has been studied by Ovchavenko[3] and only three branches were reported in each band. Recently, Singh and Singh[4] photographed the β-system of the SiF molecule and five branches were observed in the (0, 0) band of the $^2\Sigma^+$–$^2\Pi_{3/2}$ sub-system. The B-X system of the SiCl molecule has been recorded in the third order of Jarall-Ash grating spectrograph at 0·7 Å/mm. dispersion and the spin splitting constant (γ) has also been obtained. The enlargement of the (0, 0) band of $^2\Sigma^+$–$^2\Pi_{3/2}$ sub-system is given in Fig. 1.

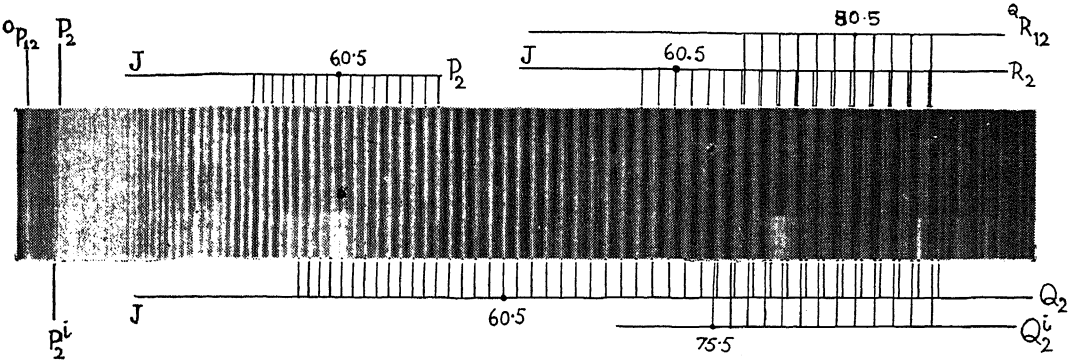

FIG. 1. $(0, 0)_{3/2}$ Band of SiCl molecule.

Apart from the main P_2, Q_2 and R_2 branches, the satellite $Q_{R_{12}}$ and isotopic Q branches have also been resolved at higher J values. The heads are formed by $O_{P_{12}}$ and P_2 branches. The rotational analysis has been performed by the usual procedure[5] and the constants thus obtained are given in Table I. The ground state rotational constants are in good agreement with those obtained by Verma[2] while the upper state constants as given by Ovchavenko[3] have been modified.

TABLE I

Rotational constants of the $(B\text{-}X)_{3/2}$ Sub-system of SiCl Molecule

	Be (cm.⁻¹)	α_e (cm.⁻¹)	r_e (Å)	D_e (cm.⁻¹)	γ (cm.⁻¹)
$B^2\Sigma^+$ ..	0·2794	0·0025	1·971	$1{\cdot}35\times10^{-7}$	0·0098
$X^2\Pi_{3/2}$ ..	0·2563	0·0016	2·057	$2{\cdot}16\times10^{-7}$	

The authors are thankful to Prof. Rais Ahmed for his kind interest in the work. One of the authors (R. K. Mishra) is thankful to the U.G.C. for the financial assistance.

Department of Physics, R. K. MISHRA.
Aligarh Muslim University, B. N. KHANNA.
Aligarh, *May* 3, 1969.

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CRYSTAL STRUCTURE OF COPPER ETHYL SULPHATE TETRAHYDRATE

THE crystal structure of copper ethyl sulphate tetrahydrate, $Cu(C_2H_5SO_4)_2.4H_2O$ has been determined by X-ray diffraction methods. The crystal is orthorhombic $a = 9 \cdot 72$ Å, $b = 7 \cdot 30$ Å and $c = 19 \cdot 70$ Å and belongs to the centro-symmetric space group Pbca. There are four molecules per unit cell according to the experimentally measured density 1·79 mg./c.c.

In this space group of multiplicity 8, the four copper atoms occupy special positions at centres of symmetry. The positions of the other atoms were derived from interpreting the (100) and (010) Patterson projection maps. These agreed well with the *okl* and *hol* diffraction data. The structure has been refined by least squares method using all available diffraction data.

The bond characteristics of the acidic ethylsulphate radical agree very well with those of other published structures. The Cu^{++} ion has a slightly distorted octahedral co-ordination of six oxygen atoms—two at 1·98 Å and two more at 1·96 Å from Cu make a near perfect square with Cu at the centre, and two other oxygens at 2·39 Å from Cu^{++} complete the octahedron.

The structure consists of chains of $Cu(C_2H_5SO_4)_2.4H_2O$ parallel to the *c*-axis. Adjacent chains are held by a system of hydrogen bonds from each water oxygen of one chain to ethyl sulphate oxygens of adjacent chains.

The R-factor for 526 observed *hkl* reflections is 0·119. Table I gives the co-ordinates of the atoms and their respective isotropic temperature factors. The bond-angles are given in Table II. Figure 1 indicates the intramolecular and intermolecular distances.

TABLE I
Atomic parameters in fractional co-ordinates and temperature factors in $Å^2$

	x	*y*	*z*	B
Cu	0·0000	0·5000	0·0000	2·77
S	−0·0073	0·0820	0·1034	1·90
O_1	0·1112	0·0027	0·0720	2·70
O_2	−0·1277	−0·0349	0·0949	2·49
O_3	−0·0254	0·2667	0·0839	3·04
O_4	0·0129	0·0758	0·1814	3·47
W_1	−0·1561	0·6431	0·0370	2·00
W_2	0·1289	0·6330	0·0585	2·48
C_1	0·1222	0·1889	0·2089	6·10
C_2	0·1290	0·1403	0·2834	8·10

TABLE II
Bond-angles

O_1	$\hat{S}$	O_2	111° 5′
O_1	$\hat{S}$	O_3	111° 37′
O_1	$\hat{S}$	O_4	108° 21′
O_2	$\hat{S}$	O_3	115° 18′
O_2	$\hat{S}$	O_4	101° 27′
O_3	$\hat{S}$	O_4	108° 16′
C_2	$\hat{C}_1$	O_4	105° 14′
C_1	$\hat{O}_4$	S	116° 33′

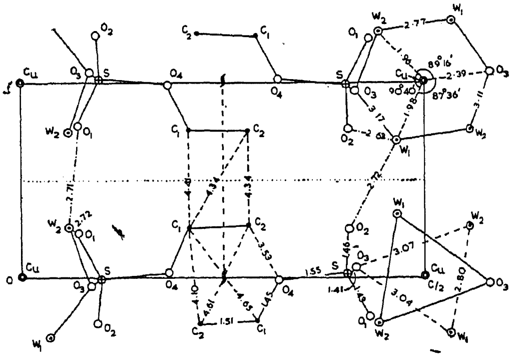


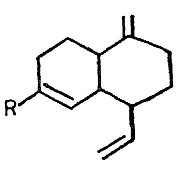
FIG. 1. Intramolecular and intermolecular distances in copper ethyl sulphate tetrahydrate (All the distances are in Å).

Department of Physics, T. M. VIMALA.
Indian Institute of S. SWAMINATHAN.
Technology,
Madras-36, *June* 3, 1969.

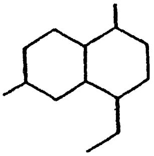
A NEW ACIDIC COMPONENT FROM THE INDIAN VETIVER OIL

In an earlier communication the chemical composition of the Indian Vetiver oil (Punjab variety) was described.[1] The present article reports on the acidic components of the oil.

Vetiver oil isolated by steam distillation of the powdered roots of the plant *Vetiveria zizanioides* Linn. was thoroughly extracted with aqueous potassium hydroxide. Acidification of the alkali extracts afforded a crude acidic product in about 0·2% yield as a dark viscous material. This was reacted with an ethereal solution of diazomethane which gave the corresponding mixture of esters as evidenced from the IR spectrum of the mixture which showed bands at 1,745, 1,700 and around 1,250 cm.$^{-1}$ due to the presence of both saturated and α, β-unsaturated esters. The mixture was purified by passing through a small bed of alumina and subjected to VPC analysis which showed the presence of seven peaks. In confirmation with this observation TLC showed the presence of at least five clearly visible spots. VPC and TLC results taken together showed the presence of one of the components in a large quantity (60%). Attempts were, therefore, made to isolate and characterize this major acidic component of the oil. This acid was isolated in the form of its ester in a pure form. Chemical and spectroscopic data showed that this compound represents the Acid I whose corresponding aldehyde Khusilal II has already been reported to occur as a major component of the Vetiver oil.[2]



I R = COOH
II R = CHO
III R = CH_2OH



IV

All attempts to isolate the components of the mixture of esters by column chromatography over alumina were unsuccessful. However, the chromatography of the esters over silica gel impregnated with silver nitrate succeeded and the above major component was isolated in a state of high purity. It analysed for $C_{15}H_{20}O_2$ (Found: C, 78·10; H, 8·84. $C_{15}H_{20}O_2$ requires: C, 77·55; H, 8·68%); IR bands at 1,700 and around 1,240 (α, β-unsaturated ester); at 3080, 1640 and 892 (methylenic double bond); at 995 and 915 (vinyl double bond) and bands around 830 cm.$^{-1}$ (trisubstituted double bond). The presence of vinyl double bond showed that this ester has probably the Khusilane carbon skeleton[2] (IV). IR data coupled with its UV spectrum $\lambda_{max.}$ 218 mμ, ε, 9,900 confirmed it to be an α, β-unsaturated ester.

Reduction of the ester with LAH afforded a crystalline alcohol which was purified by preparative TLC. It was identified as Khusilol III m.p. and mixed m.p. with an authentic sample 75° and from a comparison of their IR spectra.

Mild alkaline hydrolysis of the ester afforded the corresponding acid (I) m.p. 124°. Mixed m.p. with an authentic sample of the acid remained undepressed. Its IR and UV spectra ($\lambda_{max.}$ 214 mμ, ε, 9800) were completely identical with that of the natural product.

Department of Chemistry and Biochemistry,
Punjab Agricultural University,
Ludhiana (India), *March* 28, 1969.

P. S. Kalsi.
I. S. Bhatia.

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RETINAL FROM RETRORETINOL

Retroretinol, generally found in deteriorated samples of multivitamin preparations,[1,2] can be prepared by treatment of retinyl acetate with concentrated hydrobromic acid.[3] Barua and Rao[4] reported the formation of a compound whose absorption spectrum resembled that of retroretinol. Although there is indication of *in vivo* conversion of retroretinol to retinol[1,5] there is no report till now of the chemical conversion of retroretinol to retinol. In this communication we report a new procedure for the preparation of retroretinol and the conversion of retroretinol to retinal.

Preparation of Retroretinol.—200 mg. of retinol was treated with an alcoholic solution of dry hydrogen chloride (0·13 N.; 100 ml.) and allowed to stand for 40 minutes in the dark. The reaction mixture was then neutralised with sodium bicarbonate solution and the product was extracted with light petroleum. Chromatography of the product on water-deactivated alumina (5% water, v/w, resulted in the separation of four zones. The main greenish-yellow zone containing anhydroretinol[6,7] passed quickly through the column. The second yellow zone was eluted with light petroleum containing 1% (v/v) of ether. The substance from this zone exhibited $\lambda_{max.}$ at 330 mμ (light petroleum). The third yellow zone was eluted with light petroleum containing 5% (v/v) of ether. The substance from this zone showed $\lambda\lambda_{max.}$ at 367, 348 and 332 mμ (solvent: light petroleum). The fourth zone which was eluted, after extrusion, with ether contained a substance that exhibited $\lambda_{max.}$ at 290 mμ in light petroleum.

The substance eluted from the third zone was further purified by chromatography and the pure compound exhibited $\lambda\lambda_{max.}$ 367, 348, 332 mμ with E (1%, 1 cm.) values of 1274, 1593 and 1270, respectively, at the points of maximum absorption in light petroleum. It produced a bluish-violet colour with antimony-trichloride reagent showing $\lambda_{max.}$ at 580 mμ. In the I.R. spectrum it showed band at 3400 cm.$^{-1}$ characteristic of the –OH group. The yield of retroretinol was 10·1%.

The identity of retroretinol prepared as above was further confirmed by preparing retroretinyl acetate. Retroretinol was heated with acetic anhydride in pyridine at 50° C. for 30 minutes, the product was extracted with light petroleum and then chromatographed on a column of water-deactivated alumina (5% water; v/w). Retroretinyl acetate ($\lambda\lambda_{max.}$ 367, 348 and 332 mμ in light petroleum) was eluted with light petroleum. It produced a violet colour with Carr-Price reagent showing $\lambda_{max.}$ at 575 mμ with a minor maximum at 470 mμ.

The ultra-violet and I.R. spectra and $SbCl_3$ colour absorption maxima of retroretinol and retroretinyl acetate prepared by this new procedure and those prepared by the procedure outlined by Beutel *et al.*[3] were found identical in all respects. Further, co-chromatography of samples of either retroretinol or retroretinyl acetate prepared by these two procedures, on a column of water-deactivated alumina showed that the compounds were identical. Only a single zone was formed on the chromatogram and prolonged development did not effect separation of the zone.

Conversion of Retroretinol into Retinal.—20 mg. of retroretinol obtained by the above procedure was dissolved in 10 ml. of light petroleum and passed through a column of manganese dioxide (300 mg, precipitated, B.D.H.). The filtrate was concentrated and chromatographed on a column of water-deactivated alumina (8% water, v/w). The substance from the main zone which was eluted with light petroleum or better with light petroleum containing ether (1-2%, v/v), was found to be retinal (1·2 mg.). $\lambda_{max.}$ 369 mμ in light petroleum and 380 mμ in ethanol; $SbCl_3$ colour maximum at 660 mμ.

Retinal thus obtained was found to be identical with an authentic sample prepared from retinol by the method of Ball, Goodwin and Morton[8] in their ultra-violet and $SbCl_3$ colour-visible spectra. Mixed chromatography of the two retinal samples did not result in the separation of zones.

Retinal (10 mg.), prepared from retroretinol, was reduced with $NaBH_4$. The reduced product after chromatographic purification was found to be retinol (7·56 mg.), $\lambda_{max.}$ 325 mμ; $SbCl_3$ colour $\lambda_{max.}$ 617 mμ. Treatment of retinol with 0·033 N ethanolic hydrogen chloride followed by purification by chromatography gave anhydroretinol, $\lambda\lambda_{max.}$ 390, 369 and 350 mμ; $SbCl_3$ colour $\lambda_{max.}$ 617 mμ.

Retinal was also obtained in 6% yield when retroretinol, prepared by the procedure of Beutel *et al.*,[3] was oxidised with MnO_2.

Department of Chemistry, University of Gauhati, Gauhati-14, Assam, *March* 18, 1969.
K. K. Das.
A. B. Barua.
N. N. Siddhanta.

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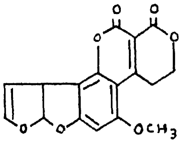
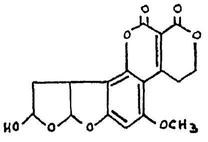
AFLATOXIN G_1 HEMIACETAL

It has been recently reported[1,2] that aflatoxin-containing extracts from cultures of *Aspergillus flavus* contain two other metabolites apparently related to the aflatoxins, namely, aflatoxin B_{2a} and G_2 Of these the former has been shown to be identical with aflatoxin B_1 hemiacetal obtained by hydration of aflatoxin B_1.[3,4] But no parallel study appears to have been made on the latter. In view of this, the present investigation was undertaken to prepare aflatoxin G_1 hemiacetal by direct hydration of aflatoxin G_1 (I) and to prove its identity with aflatoxin G_{2a} (II).



I



II

The hemiacetal is obtained by stirring aflatoxin G_1 with dilute acids at room temperature. In a typical run aflatoxin G_1 (10 mg.) is magnetically stirred with 25 ml. of 5% sulphuric acid at 28° C. for 24 hr. The resulting aqueous solution is extracted six times with 20 ml. portions of chloroform; the combined extract is dried over anhydrous sodium sulphate and evaporated to 10 ml. Thin layer chromatography (TLC) of the extract using silica gel G (according to Stahl) and an eluant of 3% methanol (by vol.) in chloroform indicated the presence of two compounds. The first, fluorescing green under uv light had R_f 0·48 (corresponding to unreacted aflatoxin G_1[5]), whereas the second, fluorescing intense green had R_f 0·13. The latter was isolated from the extract by preparative TLC. An apparently unstable yellow amorphous powder, m.p. 192–194°, was obtained by crystallisation from methanol; purity of the final product is judged on the basis of appearance of a single spot on TLC using several solvent systems. The weight of the recovered material amounted to 60% of the weight of aflatoxin G_1 used.

The new compound produced intense green fluorescence in methanol and chloroform solutions. Its uv spectrum was similar to that of aflatoxin G_1[5] (maximum absorbancy in methanol at 245, 257, 263 and 362 mμ). The infrared spectrum of the substance was very similar to that of aflatoxin G_1[5] except for an additional band at 3600 cm.$^{-1}$ indicating the presence of a hydroxyl group.

Reaction of the hemiacetal with acetic anhydride in pyridine followed by pyrolysis of the resulting compound at 220° C. and at 3 mm. pressure for 10 min. afforded aflatoxin G_1 as determined by TLC.[5] This observation lends chemical evidence to the view that the OH group in the hemiacetal molecule is at position 2 of the terminal tetrahydrofuran ring, because, if it were at position 3 the preferred pyrolysis product would have been an isomer of aflatoxin G_1 with the double bond between positions 3 and 4.[6]

Co-chromatography of the new product with aflatoxin G_{2a} which was prepared by the method of Dutton and Heathcote[1,2] gave only a single spot on TLC plates, further confirming the identity of the two compounds.

The author wishes to thank Dr. James Verghese, Head of the Department of Chemistry and Dr. Jacob Chandy, Principal, for their keen interest in this work. The award of a Research Grant by the Research Committee, Christian Medical College, is gratefully acknowledged.

Dept. of Chemistry, C. Poonnoose Mathew.
Christian Medical College,
Vellore-2, Tamil Nadu,
April 7, 1969.

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CHEMICAL RACES IN *FOENICULUM VULGARE* MILLER

During our studies in umbelliferous fruits a sample of fruits was supplied as *Anise* fruits (*Pimpinella anisum* L.) by the Botanist, Government Cinchona Plantation, Dodabetta, Ooty. The morphological and microscopical characters, especially the absence of epidermal hairs and presence of only six vittæ proved beyond doubt that the fruits were not *Anise* fruits. The microscopical characters resembled more to fennel though in morphological and sensory characters they even differed from fennel, in size, smell, darker colour and in their occurrence as separate mericarps and not possessing sweet taste.

The fruits and herbarium specimens were sent to Kew Gardens, England, and identified as fruits of *Fœniculum vulgare*. The volatile oil content of the fruits was much higher and upto 8%. The volatile oil did not possess the characteristic smell and taste of anethole, the chief constituent of fennel,[1] and did not show congealing. This led to the suspicion that either anethole might be present to a small extent or it might be totally absent. By TLC studies using silica gel G according to Stahl as adsorbent and anethole and methyl chavicol as reference substance the colour tests showed the presence of methyl chavicol.[2] Separation of methyl chavicol was carried out by column chromatography and its fraction was used for infra-red spectroscopy. By I.R. of separated constituent as well as of pure sample, identity of methyl chavicol was confirmed.

Further, advantage was taken of allylic chain in methyl chavicol which was separated from anethole on TLC plates by using silica gel G according to Stahl impregnated with silver nitrate, as recommended by Nano and Martelli.[3] Only one spot corresponding to methyl chavicol was obtained and anethole was found to be absent.

Thus the fruits of *Fœniculum vulgare* collected from Ooty were found to be free of anethole and represents a *methyl chavicol race* of *Fœniculum vulgare*. Such chemical races have been found and reported in quite a few umbelliferous fruits.[4,5]

The authors' thanks are due to the Director, Kew Gardens, England, for identifying the plant and to the Botanist, Dodabetta, Ooty, for the supply of the drug and plant specimen.

Dept. of Pharmacognosy, C. S. Shah.
L.M. College of J. S. Qadry.*
Pharmacy, Mrs. M. G. Chauhan.
Ahmedabad-9,
March 27, 1969.

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* Same as formerly S. M. J. S Qadry.

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USE OF CONGLUTINATING COMPLEMENT ABSORPTION (CCA) TEST AND CCA INHIBITION TEST FOR THE DETECTION OF ANTIBODIES TO ARBOVIRUSES

Although various workers have reported the use of conglutinating complement absorption (CCA) test as a sero-diagnostic tool in a number of viral diseases,[1–5] there is no report on the use of this technique in sero-diagnosis of arboviruses. This communication reports firstly, the application of CCA test for detecting serum antibodies in rabbits and mice after experimental arbovirus infection and in certain convalescent humans, and secondly, the development of CCA inhibition test (CCAIT) for detecting serum inhibitory antibodies in chickens after experimental arbovirus infection.

Conglutinating Complement Absorption Test.—Serum samples were obtained from rabbits and/or mice before infection and at various intervals after infection with Japanese encephalitis (JE) virus (P 20778 strain), West Nile (WN) virus (G 22886 strain) or Kyasanur Forest disease (KFD) virus (P 9605 strain). Forty convalescent human sera taken at various intervals ranging from 11 days up to five years after onset of KFD illness from twenty-two individuals were also tested.

The hyperimmune sera against each of these viruses were raised in adult mice as per method of Clarke and Clasals.[6] All sera were inactivated at 56° C. for 30 minutes.

The viral antigens were prepared from brains of infected infant mice by the acetone-ether or sucrose-acetone extraction method of Clarke and Casals.[6] The highest dilution of antigen that reacted with any dilution of hyperimmune serum and bound a dose of complement was taken as one unit and eight units were used in tests with unknown sera.

A five-volume CCA test in tubes was employed and the tests were done by the standard procedure using normal saline as diluent, 2 to 2·5 units of horse complement and an indicator system consisting of 0·25% sheep erythrocytes and 1 : 20 dilution of bovine serum conglutinin. Primary incubation of antigen, serum (two-fold dilutions) and complement was carried out at 22° C. for 30 minutes. The indicator system in two unit volumes was then added. The complete test was incubated at 37° C. for 30 minutes and thereafter all the tubes were centrifuged at 1,500 RPM for one minute. The test was read by resuspension technique. The positive reaction was indicated by 0 to 25% conglutination and negative reaction by 50% to 100% conglutination. The appropriate controls were included in each test.

Detectable antibodies in sera from rabbits and mice were recorded as early as five to ten days after infection, which increased to reach their peak titres (1 : 32 to 1 : 128) in about three weeks' time followed by a decline and persistence for 71 to 101 days, the longest period tested.

Of forty convalescent human sera, 29 were positive for KFD antibody.

It appeared from these preliminary results that CCA test could be employed for detecting presence and persistence of arbovirus antibodies in human and animal sera.

Conglutinating Complement Absorption Inhibition Test.—Serum samples were obtained from chickens after infection with JE, WN or KFD virus. The standard hyperimmune sera and viral antigens were the same as described above. Sera were inactivated at 56° C. for 30 minutes. One serum unit was the highest dilution of standard serum still capable of uniting with the specific antigen and binding a dose of complement. One antigen unit was determined in like manner.

TABLE I

Antibody response of chickens infected with JE virus as measured by CCAI, CFI and HI Tests

Chicken No.	Days post-infection	Titres*		
		CCAI	CFI	HI
81	0	<8	<8	<10
	7	32	<8	80
	14	256	64	320
110	0	<8	<8	<10
	7	<8	<8	<10
	14	1024	64	320
	21	64	32	80
12	0	<8	<8	<10
	7	16	<8	<10
	14	128	32	2560
	21	128	16	160

The dosage of Japanese encephalitis (JE) virus inoculated in each chicken = $1 \cdot 7 \times 10^4$ LD_{50}.

* Titre was expressed as reciprocal of the final dilution.

CFI = Complement fixation inhibition.
HI = Hæmagglutination inhibition.

The CCAI tests were done in tubes with the specific reactive system consisting of antigen and its standard antibody, and the indicator system. Preliminary incubation of chicken serum (two-fold dilutions) and antigen (1 to 1·5 units) was carried out at 22° C. for 30 minutes after which horse complement (2 units) and standard serum (1 to 1·5 units) were added. Following reincubation of the test at 22° C. for 30 minutes, the indicator system was added. The complete test was finally incubated at 37° C. for 30 minutes. The results were read after centrifugation in the same way as in the set up of the CCA test but designating 75% to 100% conglutination as positive reaction and 50%, 25% or no conglutination as negative reaction. The appropriate controls were included in each test.

The results indicated that chickens developed CCA inhibitory antibodies with a fair degree of regularity following infection with JE, WN or KFD virus. The inhibitory titres were usually demonstrable seventh day post-infection and increased significantly by 14th to 17th day. The CCAI response compared favourably with the results of conventional serological tests (Table I).

The results showed that the CCAI test is sensitive, specific and rapid and could be used for serological studies of arbovirus infection in chickens.

The author is grateful to Dr. T. Ramachandra Rao for his keen interest and constant encouragement in this study.

Virus Research Centre,* GURKIRPAL SINGH.
Poona-1, *March* 13, 1969.

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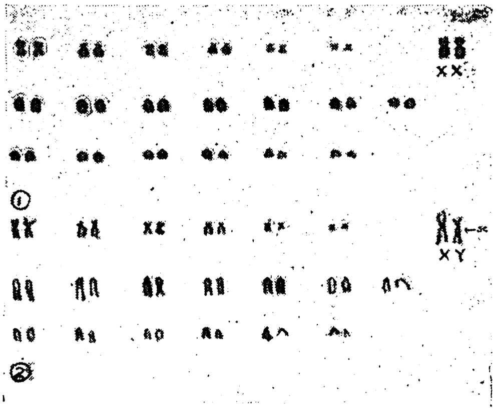
CHROMOSOMES OF THE HOUSE SHREW *SUNCUS MURINUS* (INSECTIVORA)

IN an earlier study of the Indian house shrew, *Suncus murinus* (Soricidæ-Insectivora) Manna and Talukdar[1] reported the chromosomes from bone marrow of a single male. We have studied the chromosome complements from bone marrow as well as cells grown *in vitro*. Our observations are at variance with those of Manna and Talukdar. Moreover, we have observed in this species the presence of unusually large sex chromosomes not so far reported for any Insectivore species.

Fourteen animals (eight males and six females) were collected from the environs of the University Campus. Foetal tissue cultures were set up from a total of five embryos from two pregnant females using Parker 199 medium supplemented with 15% calf serum and antibiotics. Chromosome preparations were made from coverslip cultures after 2 hours of colchicine (0·40 μg./ml.) followed by a brief hypotonic treatment. Bone marrow chromosomes were prepared according to the method described earlier.[2]

The detailed karyotypes of female and male are shown in Figs. 1 and 2. From an examination of 100 metaphases from both sexes the diploid number was determined to be 40. The karyotype consists of 6 pairs of metacentric and sub-metacentric chromosomes and 13 pairs of acrocentrics. The X-chromosome is the largest metacentric (mean chromosome length, 10·7 μ; arm ratio, 1·37) and Y is the second largest sub-metacentric (mean chromosome length, 7·5 μ; arm ratio, 2·24) in the complement. Measurements of these indicate that the X-chromosome constitutes about 11·2% and Y about 8·6% of the total haploid complement. The Y-chromosome shows a prominent secondary constriction at the proximal end of the long arm, close to the centromere (Fig. 2).



FIGS. 1-2. Fig. 1. Female karyotype showing 6 pairs of meta- and sub-metacentric chromosomes and 13 pairs of acrocentric chromosomes. Note the largest size of the X-chromosomes. (Bone marrow), × 600. Fig. 2. Male karyotype. Note the largest sex chromosomes. The Y-chromosome shows a secondary constriction (arrow). (Embryonic cell culture), × 600.

The diploid number of 40 is in agreement with the number reported by Manna and Talukdar. However, they found four pairs of meta- and sub-metacentric chromosomes and 15 pairs of acrocentrics in contrast to our observations (Table I). Our observation on the basis of a comparison of karyotypes of both males and females indicate that the X-chromosome is the largest metacentric and Y is a sub-metacentric and second largest in the complement. A detailed autoradiography study of DNA replication further confirms the identification of sex chromosomes. The X in female and Y in male which show out-of-phase replication are the ones indicated from karyotype studies (unpublished).

TABLE I

Observations	Manna & Talukdar	This report
Diploid number :		
Male ..	40	40
Female ..	Not done	40
Autosomes :		
Meta- and sub-metacentrics	4 pairs	6 pairs
Acrocentrics ..	15 pairs	13 pairs
Sex chromosomes :		
X-chromosomes ..	One of the large sub-metacentric (mean length, 3·08 μ)	The largest metacentric (mean length, 10·7 μ)
Y-chromosome ..	Small acrocentric (mean length 0·96 μ)	Second largest, sub-metacentric with a secondary constriction, (mean leugth, 7·5 μ)

In a large number of mammals with the XY type of sex chromosomes, the X constitutes about 5% of the total haploid complement and is generally referred to as "original-type". However, deviations from the "original-type" are known to occur in a few mammals. If the X-chromosome constitutes about 10% (*e.g.*, golden hamster, *Mesocricetus auratus*[3]; chinchilla, *Chinchilla langer*[4]) and 15% (creeping vole, *Microtus oregoni*[3]) of the haploid set, they are considered to be "duplicate-type" and "triplicate-type" respectively. Recently, large sex chromosomes almost nearer to the "triplicate-type" have been reported in Artiodactyla for Sitatunga (*Tragelaphus spekei*) and the Blackbuck (*Antilope cervicapra*[5]). Our observation on *Suncus murinus* also indicates an unusually large sex chromosomes which belong to the "duplicate-type".

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Department of Zoology,
University of Delhi,
Delhi-7, India,
April 30, 1969.

V. K. Sharma.
S. R. V. Rao.
V. C. Shah.

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A PRELIMINARY NOTE ON A HAEMOGREGARINE FROM THE GECKO; *TARENTOLA ANNULARIS* IN THE SUDAN

A large number of hæmogregarines has been described from land reptiles[1] and many species were reported from lizards and geckos in particular.[2-5]

During the present study, 44 geckos collected from the Khartoum area were examined for their blood parasites. Out of these, 29 (65·9%) were found to be infected with hæmogregarines. Eighteen animals showed pure infections with these parasites whereas the rest of the geckos showed double infections with these hæmogregarines together with a hæmosporidian parasite.

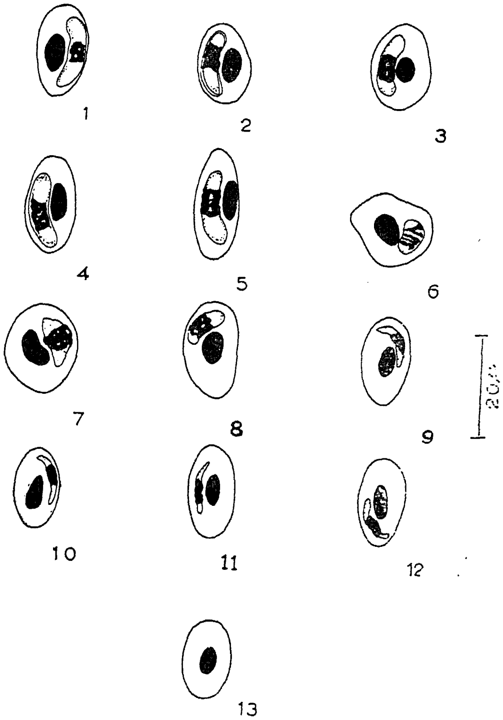
Generally, two main forms of these hæmogregarines were found in the red blood corpuscles of the infected geckos.

1. *Elongated mature forms* (Figs. 1-5).—Most of the films prepared from peripheral blood have this form. The parasites are elongated, having the typical hæmogregarine shape. Usually, one end of the parasite is pointed whereas the other end is rounded. However, in some cases both ends are invariably rounded. Although some parasites have straight bodies, the majority have slightly curved ones. Rarely, one end of the parasite may be slightly bent or hooked. The length of these forms varies from 12·4–15·9 μ (Mean: 14·4 μ), with a maximum breadth of 3·2–5·5 μ (Mean: 4·3 μ).

The parasites are enclosed in delicate but conspicuous capsules. The cytoplasm stained with faint blue Giemsa and quite often it is homogeneous and non-granular, however, in others the parasite takes a deep blue stain and it appears to be dense having a large number of closely packed granules. These differences in the staining reactions of the parasites stained under the same conditions are probably due to the presence of sexually dimorphic forms of these organisms.

The nucleus of the parasite, which takes a dark red stain, is relatively large and it generally lies in the middle third of the parasite although it may be found occasionally nearer to either ends. The chromatin material inside the nucleus will form a non-compact mass and in some cases, the chromatin granules are arranged in lines which run across the whole breadth of the parasite. Occasionally, a number of extra-nuclear chromatin granules are observed in the cytoplasm of some parasites.

2. *Young forms* (Figs. 6-12).—These are of two types: (*a*) *Oval forms*: These are small, oval intra-erythrocytic parasites. The youngest oval form recorded measures 6·9 × 4·9 μ whereas the largest seen measures 9·7 × 6·2 μ. In these forms the nuclei are compact and relatively large.



FIGS. 1–13. Hæmogregarines of *Tarentola annularis*. Figs. 1-5. Elongated mature forms. Figs. 6–8. Young oval forms. Figs. 9–12. Young thin forms. Fig. 13. Normal red blood corpuscle of *Tarentola annularis*.

(*b*) *Thin forms*: These are delicate, elongated and slightly curved intra-erythrocytic forms. They measure 8·1–9·2 μ × 2·2–3·0 μ (Mean 8·7 × 2·6 μ) and the nucleus which is almost central is large and occupies the whole breadth of the parasite.

Irrespective of the size of the parasites, the host cells are slightly hypertrophied and their outline is invariably distorted. The mature elongated forms produce a marked displacement of the host cell's nuclei but the young forms generally do not produce any change in the position of these nuclei.

It is evident that the parasites described above are undoubtedly hæmogregarines. The mature elongated forms are most probably gametocytes, whereas the young forms would represent early stages in the formation of two distinct types of development, thus the oval young forms may develop into an early erythrocytic schizonts whereas the thin forms are probably merozoites which will develop to form the elongated mature forms. These assumptions about the pathways of the various forms of the parasite in the blood of the final host can be arrived at if we take into consideration comparable forms of other well-studied related hæmogregarines of poikilothermic vertebrates.[6,7]

The problem of identifying the present parasites to the generic level is a fairly difficult one. It is believed that the generic identification of hæmogregarines depends mostly on the biological features of these parasites in their invertebrate hosts.[8] With very few exceptions, the hæmogregarines of land reptiles were assigned to the genera *Schillakia* Reichnow, *Karyolusus* Labbe or *Hœmogregarina* Laveran and Negre on very arbitrary basis.[1]

To the best of our knowledge, the only record of hæmogregarines in the geckos of the Sudan is that of Riding.[9] There is little doubt that a further study on the other stages of the present parasites in the organs of the vertebrate host together with a thorough search for its invertebrate phase once its vector is known, will throw light on its proper identification.

Department of Zoology, M. F. A. Saoud.
University of Khartoum, Saadia A. Younis.
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VARIETAL RESISTANCE TO *BRUCHUS* SP. IN COWPEA (*VIGNA SINENSIS*) UNDER STORAGE CONDITIONS

Bruchus sp., locally known as Dhora, is an important stored grain pest of cowpea. The average annual loss caused by this insect in the storage in the country is estimated at 16–20%. In the present investigation an attempt has been made to find out the degree of resistance in some cowpea varieties for possible selection of resistant strain for large-scale cultivation.

During the year 1967, forty varieties of cowpea of exotic and indigenous origin were put for varietal testing in four replications in petri dishes. In each replication 100 seeds of each variety were used. Petri dishes containing the seeds were put in fine sieved cage and an insect population at the rate of 10,000 weevils per replication was introduced in the cage. As moisture content of the seed plays an important role in the storage of seed, samples were drawn from the varietal bulk having 8–10% moisture content for this purpose. The observations regarding the damage were recorded after 65 days of starting the trial. All the observations were recorded under normal room temperatures of 22° C.

These observations indicated that the damage caused by these pests ranged from 1 to 100%. This also helped the authors to grade the varieties into five different groups, namely, resistant, tolerant, low susceptible, medium susceptible and highly susceptible. The results are shown in Table I.

Table I

Varietal resistance to Bruchus *in cowpea* (Vigna sinensis)

Sl. No.	Group	Damage Range %	No. of varieties with examples
1	Resistant	1-2	1.(T_2)
2	Tolerant	14-25	9. EC 598A, EC, 1959
3	Low susceptible	27-53	11 EC 2543 and EC 598
4	Medium susceptible	63–80	4 EC 4216, Suttons white-seeded
5	Highly susceptible	81–100	15 RS 9, Pusa Barsati

From the above results it can be concluded that variety T2 of cowpea (*Vigna sinensis*) which has shown a high degree of resistance towards the storage pest *Bruchus* sp. can be used as a donor parent for breeding against susceptibility to this insect.

Government Agriculture Research Station,
Durgapura, Jaipur
(Rajathan), *March* 15, 1969.

R. P. CHANDOLA.
K. B. TREHAN.
L. R. BAGRECHA.

EVIDENCE FOR POPULATION DIFFERENTIATION IN *MARSILEA MINUTA* L.

As early as 1922 Turesson[1] had shown that species are composed of a mosaic of populations, which he termed as ecotypes, each being adapted to a particular habitat. This adaptation may be 'any feature of an organism or its parts which is of definitive value in allowing that organism to exist under the conditions of its habitat'.[2]

While studying the responses of *Marsilea* species obtained from different parts of the country, to various edaphic and climatic factors,[3] it was noticed that the plants of *M. minuta* collected from roadside ditches at Chandauli (Varanasi, India) did not produce sporocarps even after prolonged cultivation for two years. Field observations also did not bring to record the production of the sporocarps by plants in nature. Accidentally, it was observed that the plants of the same collection had produced sporocarps in the garden while growing on a heap of farm-yard manure. An analysis of the soil from the roadsides at Chandauli revealed a very low organic matter content (1·1%), low nitrogen content (1·2 mg./100 g.) and high exchangeable calcium content (12·8 m.e.%). The soil analysis from other places where *M. minuta* grew, gave 2·2 to 4·7% organic matter, 2·7 to 4·6 mg./100 g. nitrogen and 3·6 to 11·8 m.e.% exchangeable calcium.

An experiment was designed to study the responses of the different *Marsilea* collections to the soil organic matter content. Five-internode pieces of rhizomes taken from clonal cultures of various *Marsilea* collections were planted in pots filled with garden soil and farm-yard manure mixed in different proportions. All the pots were uniformly watered daily. The analysis of soil showed the organic matter content of the pots to vary between 0·4% and 13·2%. It was noted that the plants from roadsides at Chandauli produced sporocarps at a very high organic matter content of the soil (13·2% only) while the plants of the same species collected from other places at Varanasi, Alwar, Ahmedabad, Kanpur, Gorakhpur, Meerut, Patna and Ajmer, etc., produced the sporocarps in a very wide range of the same (0·4 to 13·2%). It was also noted that when pieces of the Chandauli roadside clone producing sporocarps, under the influence of high organic matter content, were transplanted back on the soil with less organic matter content, the plants stopped producing sporocarps further. These observations thus reveal that the plants from Chandauli roadsides represent an ecologically and physiologically different population.

Mehra and Loyal,[4] working on the cytology of different *Marsilea* species, recorded three different biotypes in *M. minuta* based on morphological differences in the sporangial contents and the chromosome behaviour at meiosis. These authors also visualised the presence of 'ecotypes' in *M. minuta* as their three biotypes came from three different parts in India. An examination of the sporangial contents from the sporocarps of plants under study further revealed that in Chandauli roadside population the sporangia contained only 16 'monads' while in other cases the number of aberrant spores and pseudospores varied widely. This adds to the fact that genetically also the Chanduali roadside population is different from those examined in this study. Undoubtedly it is the genetic set-up of an organism that regulates its physiological responses so specifically and also within a decided range.

Thus, sufficient evidence exists to say that Chandauli roadside population represents an ecotype in the *M. minuta* species complex while the other populations have yet to be established for their habitat preferences.

My grateful thanks are due to Prof. R. Misra for his valuable suggestions and laboratory facilities.

Department of Botany,
Banaras Hindu University,
Varanasi-5, India, *March* 18, 1969.

BRIJ GOPAL.

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PALEALESS MUTANT IN AFRICAN CULTIVATED RICE *ORYZA GLABERRIMA* STEUD.

A STUDY of the effect of chemical mutagens in rice was undertaken at this Institute. During the investigation dormant seeds of African cultivated rice, *O. glaberrima* (Ac. No. CG-1) were soaked in water for 12 hr. and then treated with EMS 0·4% for 48 hr. at 18° C. with periodic stirring. The seeds were rinsed with water and planted in flat pans. The M_1 plants were bagged and then harvested singly. The M_2 generation was grown with 20 plants/progeny. In one progeny (No. 1604) consisting of fifteen plants which grew to maturity three plants had panicles in which all the spikelets showed the complete absence of palea, thereby exposing the stigma and anthers. The fertility of these spikelets of the mutant plants was normal, but the seeds were slightly shrivelled up as they remained exposed throughout their development (Fig. 1).

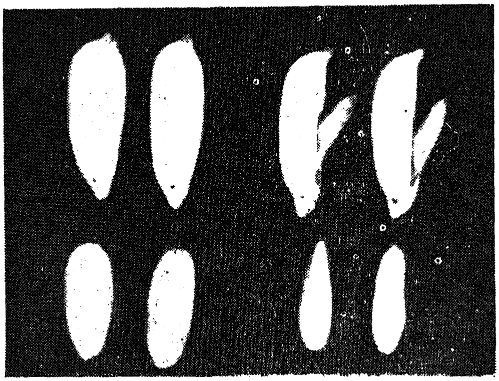

FIG. 1. Spikelets and kernels of normal *O. glaberrima* (left) and mutant plants (right).

In the three mutant plants, mentioned above, a few panicles were bagged (selfed) immediately after heading to avoid natural cross-pollination. The other panicles were left, without bagging for natural seed setting. Simultaneously, crosses were attempted between the mutant and normal plants from the control using the mutants as the female parent. Five crossed seeds were secured of which only two grew to maturity and both of them showed normal development of lemma and palea in the spikelets showing the dominance of the normal spikelets over the *palealess* condition in the F_1. The M_3 progenies from the selfed panicles of the mutants bred true where all the spikelets in the panicles were *palealess*, showing complete penetrance and expressivity of the mutant character. When the seeds of the unselfed panicles were grown the progenies segregated for normal and *palealess* mutant indicating that some of the spikelets of the mutants in the M_2 were cross-pollinated by foreign pollen.

The seeds of the two F_1 plants segregated into normal and *palealess* mutants in the F_2, forty-five normal and thirteen *palealess* for the first cross (P for 3 : 1 ratio is 0·90–0·80) and fifty-three normal and fifteen *palealess* for the second cross (P for 3 : 1 ratio is 0·50–0·30).

When M_3 families of five morphologically normal M_2 plants were grown (23 plants/family) three bred true for normal spikelets, one segregated eighteen normal to five *palealess* (P for 3 : 1 ratio is 0·70–0·50) and the fifth family segregated nineteen normal to four *palealess* (P for 3 : 1 ratio is 0·80–0·70). Thus the breeding behaviour of the mutants were subsequently confirmed in the next generation, that is in M_3.

Ramiah and Parthasarathy (1938), and Narahari and Bora (1963) had obtained such mutants in *O. sativa* by irradiation, but the inheritance of this mutation was not worked out as the spikelets were completely sterile.

This character *palealess* spikelet, is controlled by a single recessive gene, now tentatively designated as *pa* for the following reasons: (1) It first appeared in the M_2 generation in which the family showed a segregation of twelve normal to three *palealess* mutants; (2) the panicles bred true in the M_3 generation (3) the F_2 population of the cross between normal and mutant segregated for normal and mutants in a 3 : 1 ratio; and (4) two of the normal plants from the M_2 segregated in the M_3 for normal and mutants in a 3 : 1 ratio.

This new mutant character would facilitate making a large number of crosses due to the natural absence of palea. The possibilities of utilising this mutant in the exploitation of hybrid vigour in rice are being explored.

The authors are thankful to Dr. S. Y. Padmanabhan, Director, for facilities and encouragement. This research has been financed in part by a grant under PL. 480.

Central Rice Res. Inst.,
Cuttack-6, Orissa, India,
March 26, 1969.

P. J. JACHUCK.
S. SAMPATH.

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MEIOTIC STUDIES IN *TARGIONIA HYPOPHYLLA* L.

THE present studies are concerned with the cytological investigations in the liverworts growing in this region. For this purpose, the materials were collected from Parasnath and Netarhat, which are situated on the Satpura Vindhyan Range in the Gangetic plains. *Targionia hypophylla* L. occurs abundantly at an altitude of about 1,000 to 1,170 metres to 3,500 metres on moist rocks in shady places towards the northern slopes of the hill.

The species collected are dioecious and the female plants bear the archegonia at their tips. The involucre enclosing the sporogonium is sub-globose, keeled and purple in colour. Within each involucre one or two sporogonia are met with.

For cytological studies, the capsules were taken out of the involucre, fixed in acetic alcohol (1 : 2) in the field and stored at 0° C. Then the capsules were teased out in a drop of acetic alcohol on the slide and the mother cells were allowed to spread uniformly. When the fixative evaporated, a drop of acetic carmine was put on the slide. It was then warmed constantly for a few minutes, after which a drastic pressure was applied. This helped in removal of oil droplets from the mother cells. Bright staining was obtained by this method. The slides were made permanent following acetic alcohol series. The photographs were taken from permanent preparations.

A good number of dividing spore mother cells were seen at late diakinesis, metaphase 1 and anaphase I in the same sporogonium. This shows complete non-synchronization in this material. A good number of plates were analysed from which the formation of nine bivalents was confirmed (Figs. 1 *a* and 1 *b*). Out of these nine bivalents, eight are of ring type and the solitary one of rod type. The subsequent stages leading to the tetrad formation is normal and all the spores formed are of the same size. No heteromorphic bivalent is seen.

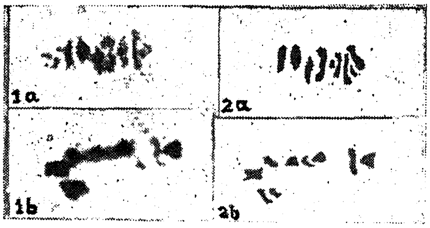

FIG. 1 *a*. A spore mother cell of *Targionia hypophylla* L. at metaphase I showing nine bivalents, × 1,000. (Explanatory diagram of the above, Fig. 2 *a*). Fig. 1 *b*. A spore mother cell of the same from different sporogonium at metaphase I showing nine bivalents, × 1,000. (Explanatory diagram of the above, Fig. 2 *b*).

The present findings are in conformity with the earlier reports from Japan in which the formation of nine bivalents has been recorded in this species.[1] The other member of the family Targioniaceæ, *Cyathodium africanum* Mitt. also shows nine as the haploid number.[2] This family, therefore, possesses nine as the haploid base number. The sporophyte is at the diploid level and there is complete absence of polyploidy.

Although *T. hypophylla* is dioecious, it is significant that no heteromorphic bivalent is seen in the spore mother cells. Sex-expression, therefore, appears to be governed at the genic level.

The authors are grateful to Prof. R. P. Roy for providing laboratory facilities and encouragement. Thanks are also due to Sri. S. Nand for microphotography.

Dept. of Botany, B. M. B. SINHA.
Patna University, ASHOK KUMAR SINHA.
Patna-5, *March* 4, 1969.

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ECOTYPIC DIFFERENTIATION IN *ELEUSINE INDICA* (L.) GAERTN.

DURING recent cytological investigations in grasses, collections were made from Gorakhpur, Eastern Uttar Pradesh, and ecotypic variation was suspected to be present in quite a few grass species. Experiments conducted to establish the ecotypic nature of the variation in *Eleusine indica* are communicated in this paper.

Six morphological variants of *Eleusine indica* were collected and cytologically examined. It was found that all of them were diploid with $n = 9$. The observations indicated that even the extreme types were not cytological races and that the differences were at the genic level. From additional evidences about the habitats in which the different morphological variants were found growing, it was suspected that at least the extreme types could be ecotypes.

The two extreme types for convenience were called "erect type" and "prostrate type". The "erect type" was found growing in favourable conditions, *i.e.*, in moist, shady and undisturbed habitats. They were, therefore, also found as a weed in flower-beds in the gardens. The "prostrate type" was found under conditions of drought, grazing and extreme pressures of trampling. Most common habitats for the "prostrate type" were footpaths on roadsides and sites which were under constant biotic influence.

Plants belonging to both ecotypes were transplanted from the fields in the neutral medium in garden pots in August 1967. The performance of these variants was observed for a year and it was found that the plants maintained their morphological identity. In order to have further confirmation, the plants were raised from the seeds. Somewhat prostrate and erect natures of the two variants were observed in these cultures also (Fig. 1). It was, therefore, established that the variants were not ecads, but definite ecotypes. The morphological characters of the ecotypes in field and in culture are given in Table I. It is obvious that for most of the characters listed, the differences, which were recorded between the ecotypes in the field, persisted in culture also.

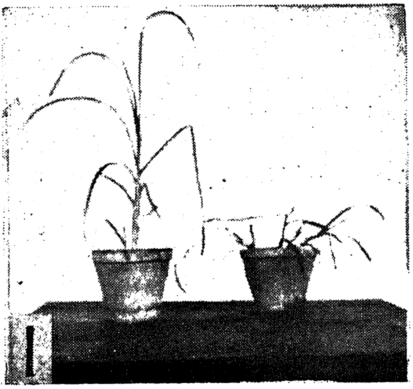

FIG. 1. "Erect" and "Prostrate" ecotypes raised from seed in culture.

The experiments and the result, presented in this paper, demonstrated that the differences between "prostrate" and "erect" types were at the genic level. However, plants intermediate between "prostrate" and "erect" types were observed both in the fields and in culture. The presence of these intermediate types demonstrated firstly that there was no isolating mechanism operating between the two types and secondly that there could be more than one gene responsible for this difference. Only crossing experiments between the "erect" and the "prostrate" types would reveal the number of genes and the type of inheritance involved.

TABLE I

Morphological characters in two ecotypes in Eleusine indica

Ecotype / Character	From field		From culture	
	Prostrate	Erect	Prostrate	Erect
Habit				
1. Height of plant	Complete prostrate to 83·0	230·0–645·0	81·0–164·0	385·0–507·0
	36·4	435·2	147·0	453·0
2. Length of culm	57·0–155·0	250·0–657·0	87·0–195·0	38·0–504·0
	96·6	466·5	128·4	453·2
1st leaf				
3. Sheath length	14·0–42·0	58·0–120·0	29·0–55·0	72·0–103·0
	29·4	88·7	40·0	81·8
4. Blade length	24·0–105·0	122·0–260·0	28·0–98·0	144·0–188·0
	72·8	202·9	66·0	164·8
Inflorescence				
5. Number of racemes per inflorescence	1–3	1–7	2–5	4–9
	2·0	4·9	3·4	7·0
6. Length of racemes	22·0–41·0	6·4–13·5	33·0–46·0	74·0–110·0
	31·5	92·9	36·4	86·8
7. Length of primary axis	0·0–5·0	0·0–44·4	0·0–22·0	11·0–31·0
	1·2	16·1	0·7	23·8

Note: 1. All measurements in mm.
2. Upper rows range and lower rows mean.

The authors are thankful to Prof. K. S. Bhargava for providing laboratory facilities.

Cytogenetics Laboratory, P. K. GUPTA.*
Botany Department, A. K. SRIVASTAVA.
Gorakhpur University,
Gorakhpur, India, *April* 2, 1969.

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* Presently Reader in Botany, Meerut University, Meerut.

REVIEWS AND NOTICES OF BOOKS

Autoxidation of Hydrocarbons and Polyolefins : Kinetics and Mechanisms. By Leo Reich and Salvatore S. Stivala. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1969. Pp. xi + 527. Price $ 29.75.

This book meets the need for a detailed quantitative treatment of autoxidation. Devoted primarily to systems of saturated liquid hydrocarbons and long-chain saturated polyolefins, the book demonstrates the mathematical methods which can be used in developing kinetic expressions from oxidation mechanisms. The authors convey the variety of phenomena associated with autoxidation, and include conflicting mechanisms and interpretations to show the need for and provide a stimulus to further research.

To acquaint the reader with some of the theoretical aspects of autoxidation, the opening chapter covers such topics as steady-state theory, rotating sector methods, copolymerization theory, and the modified Hammett equations. Subsequent chapters cover the autoxidation of hydrocarbons and polyolefins in the absence and the presence of inhibitors and accelerators. Thought-provoking problems at the end of chapters give the reader opportunities to apply to autoxidation processes the principles presented in the book. Latest information and references are included in the problems to assure timeliness. A final chapter covers the investigation of polyolefin oxidation by means of various techniques, such as thermogravimetric and differential thermal analysis.

Intended for those interested in kinetics and mechanisms of hydrocarbon and/or polyolefin autoxidations, this book can also serve as a text for graduate students, either in a course on autoxidation or in conjunction with a course in chemical kinetics or polymer chemistry.

C. V. R.

X-Rays in Theory and Experiment (2nd Edition). By Arthur H. Compton and Samuel K. Allison. (D. Van Nostrand Company, Inc., Princeton, New Jersey, Toronto, New York and London); (Affiliated East-West Press Pvt. Ltd., New Delhi), 1968. Pp. xiv + 828. Price Rs. 34·00. Rest of Asia $ 6.20.

This book under review is a reprint for the benefit of readers in India at a reduced price of a classic work which has, for many years, been an authoritative exposition of a highly important field. Its popularity and usefulness is shown by the fact that the book in the present form which was published in the year 1935 has been reprinted no less than fourteen times.

Professor Arthur Holly Compton, the senior author of the book, shared the Nobel award for physics in the year 1927 made in recognition of his discovery of the Effect known by his name which shed new light on the nature of the scattering of X-rays by atoms in matter. Just a year earlier, he had published a book on X-rays and Electrons in which he gave an account of the phenomenon and discussed its significance. Great progress was made subsequently in elucidating the nature of the Compton Effect and explaining its features in detail. All such developments and many others were fully set out and discussed in the greatly enlarged book by himself and Allison published in the year 1935.

Despite all the progress made in X-ray physics subsequent to the publication of Compton's and Allison's book, it retains its freshness and value unimpaired. Readers in India would find it most useful in obtaining a grasp of X-ray physics.

C. V. R.

The Genetics of Bacteria and Their Viruses : Studies in Basic Genetics and Molecular Biology (2nd Edition). By William Hayes. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX1 4HB, England), 1968. Pp. xvi + 925. Price 95 *sh*.

The four years which have elapsed since this book was first published have witnessed great advances in our knowledge of the molecular basis of life. The most striking has been the elucidation of the genetic code. In the first edition, the summary of the chapter on this subject states that "we do not yet know the code which any organism employs to specify even a single amino-acid". The genetic code has now been solved, mainly by the development and use of ingenious new chemical techniques. Other fields which have seen striking and important, if not such dramatic, progress are those concerned with the conformation of protein and RNA molecules, the repair of radiation damage, the mechanism of recombination, the mode of replication of viral single-stranded DNA and RNA molecules, the provirus state and its control, genetic regulation of biosynthesis, and the nature and behaviour of bacterial plasmids. All these topics are treated in detail and there is hardly a chapter, except some of the introductory ones, which has not been extensively rewritten.

The subject-matter in this edition has been dealt with in seven parts, *viz.*, I. An Introduction to Genetics; II. The Elements of Genetic Analysis; III. The Integration of Genetics and Biochemistry; IV. The Analysis of Genetic Fine Structure in Micro-organisms; V. Mutation in Bacteria; VI. The Physico-Chemical Mechanisms of Heredity; and VII. The Physiology and Genetics of Bacteriophage.

C. V. R.

Physical Chemistry. By F. Daniels and R. A. Alberty. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), Pp. 671. Price Rs. 18·00.

The popularity of this text-book on Physical Chemistry among degree students of chemistry in Indian Universities can be judged from the several reprints that it has gone through since its first Indian edition in 1958. It is a comprehensive modern presentation of physical chemistry, easy to follow and understand. The new material includes such subjects as high temperature equilibrium, fundamentals of statistical mechanics, microwave spectroscopy, high polymers, enzyme catalysis, and nuclear chemistry. Each chapter contains a large number of problems, some typical ones being worked out in the text.

A. S. G.

Animal Gametes (Female). By Vishwa Nath. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1968. Pp. 195 + 200 plates. Price Rs. 60·00.

The author, who has made a lifetime study of the subject, extending over 40 years, has brought out two monographs which will remain as definitive addition to the literature on cytology. The earlier monograph on *Animal Gametes (Male)* published in 1965 dealt with animal spermatogenesis. In the present volume the author gives a comprehensive morphological and cytochemical account of yolk formation in oogenesis of a large variety of animal groups.

The systematic treatment of the material includes nucleolar emissions and their role in yolk formation, the yolk nucleus, Golgi apparatus, vacuome and lipids in oogenesis, mitochondria in oogenesis, compound yolk and its chemical composition and origin. A special feature of the presentation is the attempt at correlation of findings by the old classical techniques and the later cytochemical and the latest electron-microscopic techniques. The 200 descriptive full-page plates add value to this exhaustive monograph useful to students and research workers in cytology.

A. S. G.

ANNOUNCEMENTS

Second Conference on Photographic Science and Technology

The Hindustan Photo Films Manufacturing Company Limited, Ootacamund, proposes to hold a Two-day Conference on 6 and 7 October 1969 at Indunagar, Ootacamund-5.

Original or review papers dealing with any aspect of photographic science and technology are invited for presentation at the Conference.

Further information can be had from the Conference Secretary Dr. S. K. Jain.

Award of Research Degree

Andhra University has awarded the Ph.D. degree to the following on subject mentioned against each:

Sri. P. Brahmananda Rao (Nuclear Physics); Sri. Ch. Suryanarayana (Nuclear Physics); Sri. A. V. B. Sankaram (Chemistry); Sri. V. R. R. M. Babu (Geology).

M.S. University of Baroda has awarded the Ph.D. degree in Biochemistry to Sri. Pravinbhai Mathurbhai Amin; and Ph.D. degree in Geology to Sri. Mukund Ganesh Hardas.

Utkal University has awarded the Ph.D. degree in Botany to Sri. Basant Kumar Nanda.

Sri. Venkateswara University has awarded the Ph.D. degree in Mathematics to Mrs. Syamala S. Rau.

Books Received

Annual Review of Physiology (Vol. 31). By V. E. Hall, A. C. Giese and R. R. Sonnenschein. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California), 1969. Pp. x + 787. Price: $ 8.50 in U.S.A.; $ 9.00 elsewhere.

Skyshooting: *'Photography for Amateur Astronomers.* By R. N. Mayall and M. W. Mayall. (Dover Publications, Inc., 180, Varick Street, New York 10014), 1968. Pp. xvii + 186. Price $ 2.50.

1259-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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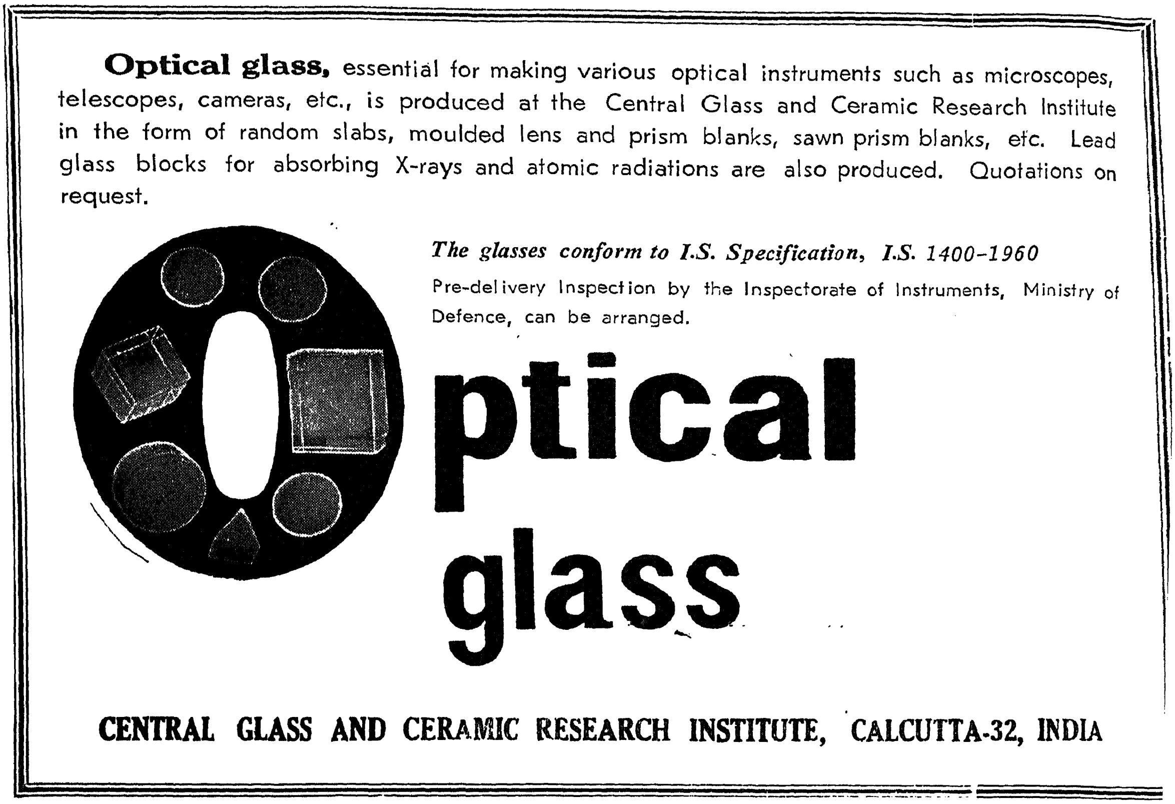

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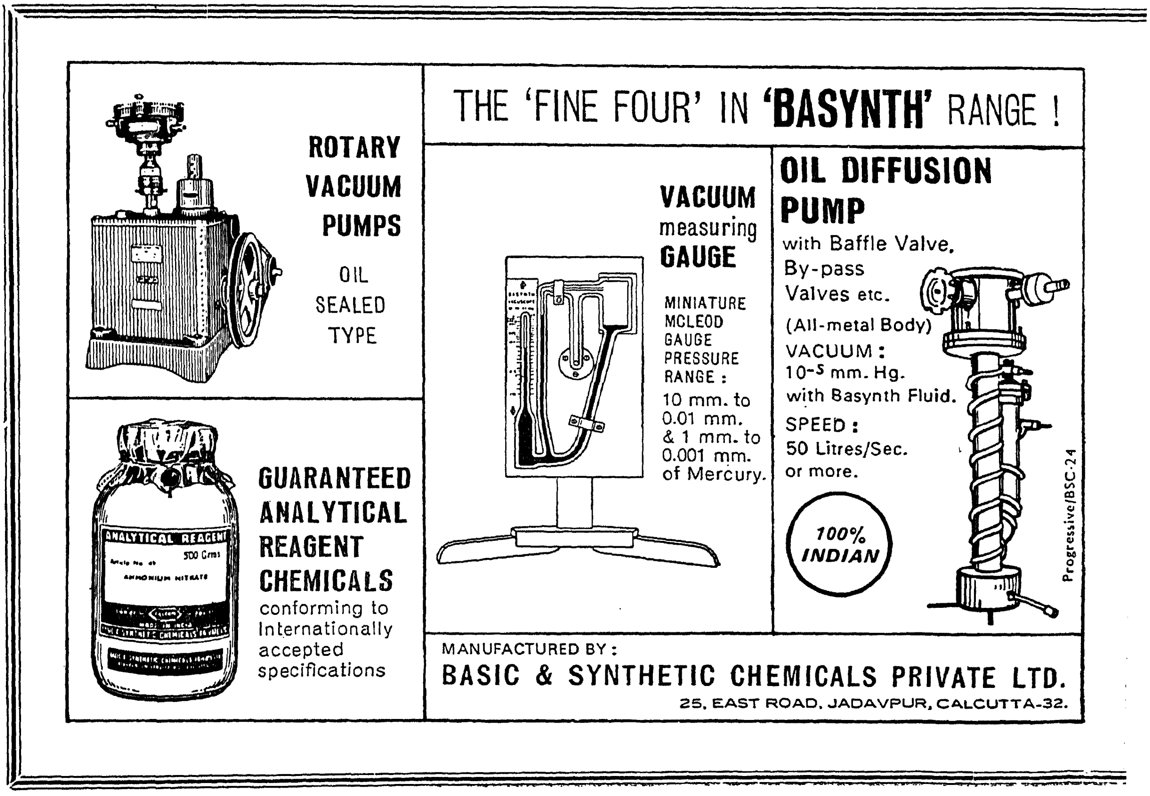

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THE AGE OF THE DIAMOND-BEARING ROCKS OF PANNA, MADHYA PRADESH

D. R. GRANTHAM, Ph.D., M.I.M.M., F.G.S.

DIAMOND source rocks are those rocks in which diamonds are found and to which the diamonds are genetically related, or "roche mere" as the French aptly call them. Diamond host rocks are sedimentary rocks containing diamonds but the diamonds were at some time detrital minerals.

Diamond source rocks are of three ages: (1) Around 100 million years, the kimberlites, which range from Upper Jurassic in Siberia, to Cretaceous for the most part, with some postulated as Early Tertiary. (2) Proterozooic, or Upper Precambrian, as at Panna, and possibly in the Diamantina area, Brazil. (3) Older than 2,000 m.y., as is evidenced by host rocks in many countries, *e.g.,* the Witwatersrand, South Africa and the Birrimian, Ghana; no source rocks of this age are yet known. Whether there are more than three ages is not known, perhaps there are not.

The Majhgawan pipe, near Panna, and, by inference, the adjacent smaller Hinota Pipe, are the only dated Proterozooic diamond pipes in the world. It is one of the objects of this paper to examine the bases for this dating.

Taking the last evidence first: Professor J. F. Lovering[1] has dated the phlogopite from Majhgawan as 1130 ± 20 million years by the Rb/Sr method at the Australian National University, Canberra. This phlogopite occurs only in certain facies of the pipe as rounded lumps, up to 1 cm. diameter; a few phlogopite flakes occur in other facies. The intrusion is clearly composite. One might surmise that the phlogopite lumps are xenocrysts; much has been written but there is, as yet, no accepted concensus of opinion on the genesis of kimberlite.

Accepting the date of the phlogopite as correct, what is the date of intrusion of the pipe? In some Siberian kimberlite pipes the phlogopite has been dated as 661 m.y. (average)[2] yet by stratigraphical evidence the pipes were definitely intruded into post-Upper Jurassic strata, say 140 m.y. There was thus a time-lag of 500 m.y. between the crystallisation and the intrusion. Were we to deduct 500 m.y. from the 1,130 m.y. of the Panna phlogopite, the date might be around 630 m.y., still just Precambrian.

Thus to attempt to date the Lower Vindhyan —the Panna pipe is intruded into Kaimur sandstone (= Dhandraul Quartzite)—by the pipe is precarious. The stratigraphic dating of the Vindhyan is still uncertain. That it contains stromatolith-like fossils, could, by comparison with African formations, take it back almost 2,000 m.y. If, in fact, uppermost Vindhyan runs up to the Palæozoic, that is not much help either; there may be long non-sequences. African experience has shown that most formations, when eventually dated, were far older than supposed.

Before the radioactive dating was received, several other lines of evidence had been considered and these are still worth setting down. The balance of evidence is in favour of the Majhgawan pipes being of Lower Rewa Sandstone (= Itwa Quartzite) age, pene-contemporaneous with the diamondiferous conglomerates in that formation.

In the writer's opinion the strongest evidence is the similarity of the diamonds in the pipe and in the conglomerates. The general type is the same and almost unique in the world. There are minor—and important—differences within this general type, from place to place, but the similarities are more striking. This implies that the diamonds are all derived from pipes of a similar type and of the same general age. He does not believe that the Majhgawan pipe fed any of the known conglomerates.

The main pipe is now exposed only a few feet below the original surface of the Kaimur Sandstone. Parts of the pipe rock are vesicular, and much of it has a glassy base. The Cretaceous land surface in this area would have been 250 metres, perhaps 300 m., higher than the present surface. It seems unlikely that a volcanic rock would be vesicular to such a depth; in other words, the vesicular nature suggests that the present surface is not far below the surface through which the pipe originally burst.

Some of the pipe rock seems to be consolidated ash; this again suggests that the present surface is not far from the original surface. (This deduction may be challenged on the grounds that ashy beds are found in the crater of the Williamson kimberlite pipe, Mwadui, Tanganyika, to a depth of 200 metres, but these are ashy lake beds laid down in the original crater lake.)

In several of the pits put down by the G.S.I. and in at least one put down by the N.M.D.C., shales were found which closely resemble the Jhiri shales exposed in the vicinity. In the G.S.I. pitting shales were found down to 12 metres below the surface. The exact type of junction between the shales and the pipe-rock and between the shales and the sandstone is still not clear, whether the shales are welded on to the sandstone walls, whether the junction is sheared, or whether the shales do not meet the walls. In one case Mathur says the junction between the shales and the pipe-rock was sharp but irregular; in another the mixture was crumpled and sheared on the small scale; the shales were shattered; sub-angular and sub-rounded blocks were mixed with blocks of siliceous material.

There are three possible mechanisms by which shales could occur in the pipe, below the level of the surface of the surrounding Kaimur Sandstone. First: there was an open explosion crater on dry land in the Kaimur surface; when the sea next invaded that area it started depositing the muds, which became shales, in the crater. Further east Mathur has observed an area of Jhiri shale, well to the north of the present main outcrop, which was due to a depression in the Kaimur floor. This would mean that the first explosion was post-Kaimur, pre-Jhiri.

Second: The shales may be "rafts" or "horses", *i.e.*, large xenoliths. In kimberlite pipes, small or immense blocks of sedimentary rock from a higher level have dropped deep into the kimberlite pipe. (The Premier Mine is the classic example.) This would imply that the pipe was later than at least part of the Jhiri shales.

Third: When a kimberlite pipe is altered by serpentinisation there is an increase in its volume; the plug of kimberlite pushes up in the pipe. This pipe-rock is not a kimberlite; its alteration is extreme; perhaps it may have sunk, rather than pushed up, and let down into the pipe area Jhiri shales which had been deposited subsequently to the pipe formation.

The writer has put forward the suggestion that the Panna shales, which die out in Shahidan as far as the present information goes, reappear further west, and that the shales in the pipe are of Panna and not Jhiri age. He does not put much weight on this suggestion.

What interpretation is to be put on the existence of shales in the pipe is by no means clear; but whichever hypothesis is adopted it does not imply that the pipe intrusion was necessarily later than an early stage of the Jhiri shales.

In the sedimentary beds to the east various members of the Lower Rewa series have been found which incorporate volcanic ash. The highest ashy bed so far found is in Jhiri shales 12 metres up from the top of the Lower Rewa Sandstone. This proves that there was volcanicity of a sort, and apparently of the same sort, of this age.

Summarising the above: The Majhgawan pipe is definitely younger than the Kaimur Sandstone. The evidence strongly suggests that it is approximately of Lower Rewa Sandstone age, the same as the conglomerates, but possibly as young as Lower Jhiri age. Nothing suggests it is younger.

Readers will have noticed above that the Majhgawan pipe-rock has not been called a kimberlite; the writer does not like calling it that, despite the fact that it is an ultrabasic rock, of somewhat similar composition to kimberlite, carrying diamonds. Kimberlites are so diverse that it is difficult to define them Petrographically the main differences are tha parts of the Majhgawan rock are vesicular and most of it has a glassy base (now entirely decomposed). How far the absence of th typical kimberlite minerals, pyrope garnet an magnesian ilmenite, can be invoked, is difficul to say. They could have decomposed in th length of time since the Precambrian. Minut grains of pyrope have been found, but onl by crushing, panning and treating in bromo form several kilograms of rock. Thes minerals do not appear in ordinary pan gravitation concentrates.

Although the chemical analyses of the pipe rock do fall within the range of kimberlite there are significant differences; magnesia very low, titania is high and alkalis are almo absent.

It is hoped that S. M. Mathur will publishing a petrological paper during t course of this year, so we will not anticipat The author would like to express his appreci tion of the excellent work done by Mathur Panna and of the help received from him.

No mention has been made of the diamond ferous conglomerates in the Upper Re Sandstone. No one knows anything about t origin of these diamonds.

APPENDIX

AN ASHY SEDIMENT

Bilkhura N.M.D.C. Pit No. 7.

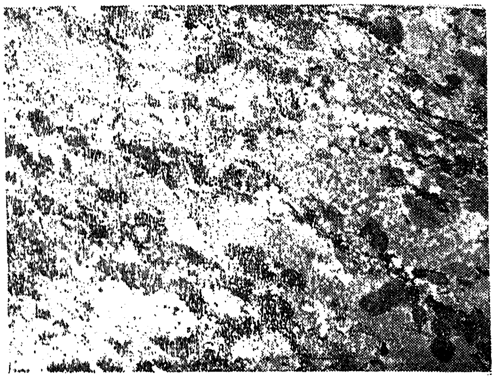

FIG. 1. Carbonated ashy sediment, Bilkhura Pit No. 7, × 10·8.

The rounded areas appearing dark gray in the photograph are pale brown with green spots; these are volcanic ash pellets, carbonated. The pale gray band diagonally across the lower centre of the photograph and in the top left corner, and much elsewhere, is finely granular carbonate. The black spots are limonite and hæmatite, probably derived from siderite. The white areas are quartz.

Specimen found in excavated material on surface. A green sandy layer, spotty with occasional 5 cm. rounded, flat pebbles. Calcite in layers and in cracks.

Composed of grains, ½ to 1 mm. mostly oval, some irregular elongated, of fine-grained material, greenish-brown (slightly weathered) to green-gray. These are set in a matrix of heterogeneous fine-grained carbonate, with a little quartz and a fair amount of limonite.

The grains (or pellets) are composed of extremely fine-grained granular carbonate, but under crossed nicols seen to be arranged in patches. Amongst this is a small amount of equally fine-grained chloritic material. Larger flakes of green chloritic material are frequent. Sometimes the chloritic material is marginal, almost a complete rim.

It is believed that these grains are volcanic ash, very small lapilli. The larger chlorite flakes may represent original phenocrysts. The glassy volcanic base has been carbonated and some of the ferromagnesian content pushed out as a rim.

The carbonate base is most curious; every grain has a spot in the centre. (It looks just like onion skin; every cell having a nucleus.) There is no evidence whether this is a carbonisation of ash or shale.

Much of the limonite is arranged in irregular lines; some forms a margin to pellets; it represents previous siderite.

A few of the quartz grains are sand grains; most are in local mosaics or layers; some are probably secondary.

The rock is carbonated volcanic ash.

---

1. Lovering, J. F., Personal communication.
2. Mikhoyenko, V. I. and Nenashev, N. I., "Absolute age of formation and relative age of intrusion of kimberlites of Yakutia," *Trans. H. Faul, Internat. Geol. Review*, Vol. **4**. No. 8.
3. Mathur, S. M., Geological Survey of India, Numerous papers published and unpublished.

IDENTIFICATION OF CHROMOSOMES CARRYING THE MAJOR GENES FOR DWARFING IN THE WHEAT VARIETIES LERMA ROJO AND SONORA 64

M. P. JHA AND M. S. SWAMINATHAN

Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi

LERMA ROJO and Sonora 64 are two semi-dwarf wheat varieties developed in Mexico by Dr. N. E. Borlaug and his colleagues, the donors of the dwarf character in them being the Japanese Norin wheats. Dwarfing in Norin wheats apparently owes its origin to spontaneous mutations in the cross Fultz-Daruma × Turkey Red.[1]

At Delhi, Lerma Rojo grows to a height of 90 cm. (mean height 91·30 ± 0·60 cm. in 1966–67 and 91·63 ± 0·24 cm. in 1967–68) in soils fertilized with 80 Kg. nitrogen per hectare. Under similar conditions, Sonora 64 reaches a height of 80 cm. (mean height 79·20 ± 0·48 cm. in 1966–67 and 80·96 ± 0·26 cm. in 1967–68). Analysis of the F_2 and F_3 progenies of crosses between these two varieties and the tall varieties Chinese Spring, Agra Local, Pissi Local and C 591 showed that dwarfing in Sonora 64 is principally controlled by two independently inherited recessive factor pairs, while in Lerma Rojo a single pair of recessive factors is involved. In order to identify the chromosomes carrying the major genes for dwarfing in these two varieties, crosses were made between them and a complete set of monosomic plants ($2n = 41$) of Chinese Spring using the monosomics as pistillate parents. The total height as well as the components of height were studied in the 41 and 42 chromosome F_1 plants in each of the 21 lines. Also, the F_2 populations derived from the monosomic F_1 plants of each chromosome line were studied for segregation for height.

Analysis of differences in height between 41 and 42 chromosome F_1 plants revealed that chromosome 6D in the case of Lerma Rojo and chromosomes 2A and 4D in the case of Sonora 64 may be the critical lines (Table I).

TABLE I

Height of monosomic and disomic F_1 plants

Pollen parent	Height of plants in cm.	
	Mean height in 1966–67	Mean height in 1967–68
Lerma Rojo		
42-chromosome derivative	117·87 ± 0·64	115·50 ± 1·41
41-chromosome (6D)	101·17 ± 1·61	99·12 ± 1·41
Sonora 64		
42-chromosome derivative	108·33 ± 0·65	111·45 ± 0·88
41 ,, (2A)	90·00 ± 1·10	102·43 ± 1·51
,, (4D)	97·65 ± 0·80	104·86 ± 1·11

This observation was confirmed by the F_2 data, which revealed a maximum deviation from the expected segregation ratios in the progenies of these chromosome lines (Table II). Thus, the major genes for dwarfing appear to be located in chromosome 6D in Lerma Rojo and 2A and 4D in Sonora 64. This observation explains why segregates containing 3 major genes for dwarfing (called "triple dwarfs") frequently occur in crosses between Lerma Rojo and Sonora 64.

TABLE II

Height in the F_2 progenies of 41 and 42 chromosome F_1 plants

Pollen parent	Mean height in cm.	Percentage plants in the height group of two parents	
		Tall parent	Dwarf parent
Lerma Rojo :			
42 chromosome derivative	114·917 ± 0·90	71·38	28·62
41 ,, (6D)	99·067 ± 0·77	27·31	72·69
Sonora 64 :			
42-chromosome derivatives	109·459 ± 0·62	88·48	11·52
41 ,, (2A)	95·695 ± 0·66	66·85	33·15
,, (4D)	100·524 ± 0·92	80·63	20·37

In addition to these major genes, several genes with small effects on height were observed in both the varieties. Factors located in as many as 17 different chromosomes influenced height in the cross Chinese Spring monosomics × Sonora 64, while factors in 11 different chromosomes were similarly involved in the cross involving Lerma Rojo. Allan and Vogel have also reported the involvement of genes located on several chromosomes in controlling height.

Analysis of the pathways of height reduction in these two sets of crosses revealed that the genes located on 6D of Lerma Rojo and 4D of Sonora 64 caused a proportionate reduction in the length of each of the five internodes generally present in these varieties. The gene on 2A of Sonora 64, on the other hand, reduces selectively the culm length (less peduncle length). The ear-bearing internode (peduncle) shows negligible reduction in the case of 2 (Fig. 1). The extent of this reduction i

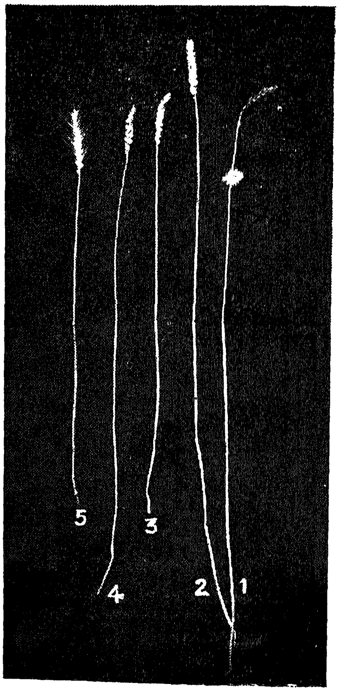

FIG. 1. Plant height and relative length of ear-bea internode in the cross Chinese Spring monosomics × So 64. (1) Normal Chinese Spring ($2n = 42$); (2) 42-chro some F_1; (3) 41-chromosome F_1 for 2A; (4) 41-chro some F_1 for 4D; (5) Sonora 64.

influenced by other factors and this might explain the occurrence of triple dwarfs in the progeny of the cross Lerma Rojo × Sonora 64 with varying degrees of peduncle exertion. From the agronomic standpoint, the 2A type of dwarfing pathway is more preferable to that of the 4D and 6D type, since a good peduncle exertion is a desirable character in dwarf varieties. Of the two major dwarfing genes in Sonora 64, the one on 2A was found to be more potent. The transfer of 2A from Sonora 64 and 6D from Lerma Rojo to the Indian variety C 591 through single chromosome substitution has already been initiated.

---

1. Reitz, L. P., *The Year-Book of Agriculture*, USDA, 1968, p. 236.
2. Allan, R. E. and Vogel, O. A., *Crop Science*, 1963, **3**, 338.

LIQUID METAL POWER GENERATOR—2

B. C. CHANDRASEKHARA, K. N. KUCHELA AND N. RUDRAIAH
Bangalore University, Bangalore

THE Magnetohydrodynamic (hereafter called MHD) power generator is an unconventional power generator in the sense that it is a direct conversion system where the thermal (or kinetic) energy is directly converted into electrical energy, whereas in the usual conventional power generator the thermal (or kinetic) energy is converted into mechanical energy and then to electrical energy. The advantages of the MHD power generator are many. Since the MHD power generator does not involve any moving mechanical part, it operates efficiently at higher altitudes compared to the usual conventional generators. Therefore, MHD power generator is very useful for defence and space research purposes. In recent years, MHD power generator has attracted many scientists (Rosa,[1] 1968). Recently, we (Chandrasekhara[2] and others, 1968 hereafter called Part, 1) discussed the liquid metal generator where we have derived expressions for the current and efficiency of the generator for arbitrary variation of density. However, in this article we consider the variation of density with height and its effect on the current and efficiency. We have also included the equivalent circuit of the generator and expressions for open circuit voltage, terminal voltage and short circuit current.

The results of Part 1 are true for any density distribution. But in most of the physical situations the variation of density decreases exponentially with height. Hence, we can write

$$\rho = \rho_0 e^{-\beta y} \tag{1}$$

where β is an arbitrary constant called the mixing parameter. In Part 1, we have derived an expression for the current in the form

$$J_L = \sigma \left[\frac{2\phi_w}{h} - \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} UB\right] L + \frac{4}{\pi}\sigma\,\phi_w \log 2 \tag{2}$$

where ϕ_w is the applied voltage, B is the applied magnetic field, σ is the electrical conductivity, ρ is the density of the fluid, L is the length and h is the height of the channel.

Equation (2), using (1) and integrating with respect to y from $-\pi/_2$ to $\pi/_2$ becomes

$$J_L = 2\sigma\left[\frac{\phi_w}{h} - \frac{2UB \sinh \frac{\beta\pi}{4}}{\pi\beta}\right] L + \frac{4\sigma\phi_w \log 2}{\pi}. \tag{3}$$

The change in total average pressure is

$$\Delta p = \pi^{-1} \int_{-\pi/2}^{\pi/2} \int_0^L (\vec{J} \times \vec{B})_x \, dx dy$$

$$\Delta p = 2\sigma BL \left[\frac{\phi_w}{h} - \frac{2UB \sinh \frac{\beta\pi}{4}}{\pi\beta}\right]. \tag{4}$$

The generator efficiency ϵ_g now becomes

$$\epsilon_g = \frac{P}{\Delta PUh} \tag{5}$$

where

$$P = -2\phi_w J_L$$

$$= \frac{2\phi_w\left[2\sigma\left\{\frac{\phi_w}{h} - \frac{2UB \sinh \frac{\beta\pi}{4}}{\pi\beta}\right\}L + \frac{4\sigma\phi_w \log 2}{\pi}\right]}{2UBhL\sigma\left[\frac{\phi_w}{h} - \frac{LUB \sinh \frac{\beta\pi}{4}}{\pi\beta}\right]}. \tag{6}$$

In the limit L → ∞ the end losses become negligible and the efficiency becomes

$$\epsilon_g = \frac{2\phi_w}{UBh} \tag{7}$$

which corresponds to the case when $\rho =$ constant. We note that using an heterogeneous conducting fluid, the total current per unit length in the direction of the magnetic field and power output are increased.

EQUIVALENT CIRCUIT OF THE GENERATOR

The equivalent circuit of the generator is as shown in Fig. 1.

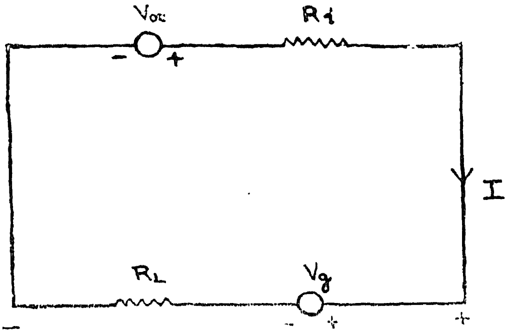

FIG 1

The open circuit voltage V_{oc} is given by setting $J_L = 0$ in Eqn. (3).

$$V_{oc} = -2\phi_w = -\frac{4UBL \sinh \frac{\beta\pi}{4}}{\beta(\pi L + 2h \log 2)}. \tag{8}$$

The negative sign indicates that the induced *e.m.f.* is in a direction opposing the applied *e.m.f.* The total short ciruit current, $J_L b = I_{sc}$ where b is the breadth of the electrode, is given by letting $\phi_w = 0$ in Eqn. (3).

$$I_{sc} = -\frac{4\sigma UBLb \sinh \frac{\beta\pi}{4}}{\pi\beta}. \tag{9}$$

Then the internal resistance of the generator is given by

$$R_i = \frac{V_{oc}}{I_{sc}} = \frac{\pi h}{ab(\pi L + 2h \log 2)}. \tag{10}$$

If L is large compared to the height of the channel then

$$(R_i)_{L,\,\text{large}} = \frac{h}{\sigma A} \tag{11}$$

where

$A = Lb.$

Using Kirchoff's law to the equivalent circuit, we obtain

$$V_{o.} - V_g = I(R_i + R_L) \tag{12}$$

where $V_g = 2\phi_w$ is the applied voltage difference between the electrodes, and R_L is the external resistance given by

$$R_L = R_c + \frac{R_{ss} R_w}{R_w + R_{ss}}$$

R_c = Contact resistance
R_w = effective wall resistance
R_{ss} = external load resistance.

Hence, the total current I, from Eqn. (12) using Eqns. (8) and (9) is

$$I = -\frac{2\sigma b}{\beta} \times \left[\frac{2UBLh \sinh \frac{\beta\pi}{4} - \phi_w \beta(\pi L + 2h \log 2)}{\pi h + R_L \sigma b(\pi L + 2h \log 2)}\right]. \tag{13}$$

If there is no applied magnetic field, the fluid can no longer generate current as it flows and Eqn. (13) becomes

$$I = +\frac{2\phi_w}{R_i + R_L}. \tag{14}$$

In the limit L → ∞ Eqn. (13) becomes

$$I = -\frac{2}{\beta}\left[\frac{2UBh \sinh \frac{\beta\pi}{4} - \phi_w \beta\pi}{R_L \pi}\right]$$
$$= -\left[\frac{\phi_i}{R_L} - \frac{2\phi_w}{R_L}\right] \tag{15}$$

where

$$\phi_i = \frac{-4UBh \sinh \frac{\pi\beta}{4}}{\pi\beta}$$

is the induced *e.m.f.* Now, the terminal voltage V_T is given by

$$V_T = V_g + IR_L$$
$$= -2\phi_w - \frac{2\sigma b R_L}{\beta} \times \left[\frac{2UBLh \sinh \frac{\beta\pi}{4} - \phi_w \beta(\pi L + 2h \log 2)}{\pi L h + R_L \sigma b(\pi L + 2h \log 2)}\right]. \tag{16}$$

The terminal voltage, in the limit R → ∞ tends to open circuit voltage. Therefore, as $R_L \to \infty$ Eqn. (16) becomes

$$V_T = -\frac{4UBLh \sinh \frac{\beta\pi}{4}}{\beta(\pi L + 2h \log 2)} \tag{17}$$

which is same as Eqn. (8).

Finally, we conclude, from Eqn. (3) that when $\beta \geqslant 0$ the induced current will increase and hence the power produced will be more.

---

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2. Chandrasekhara, B. C., Kuchela, K. N. and Rudraiah, N., "Liquid metal magnetohydrodynamic power generator," *Curr. Sci.*, 1968, **37**, 688.

LETTERS TO THE EDITOR

BETA-GAMMA CORRELATIONAL STUDIES ON THE 1710 keV $\beta \rightarrow$ 86 keV γ CASCADE IN Tb-160

THE 1710 keV beta group from the decay of Tb^{160} feeds the first excited state at 86 keV in Dy^{160}. The latter being an even-even nucleus in the deformed region, the first excited state is a component of the ground state rotational band with a 2^+ character. The ground state spin of Tb^{160} was assumed to be 4 in some earlier[1] investigations while it has been established as 3 in the later studies.[2] In the former case the 1710 keV beta transition is of the first forbidden unique type while in the latter case it is of the first-forbidden non-unique type. The log ft value (11·9), however, is unusually large for a first forbidden non-unique type of transition. The large value of log ft may be due to the reduction or cancellation of matrix elements for a first forbidden type. Alternatively, it may be due to a beta transition of higher degree of forbiddenness. To infer the nature of the 1710 keV beta transition, beta-gamma directional studies are undertaken as no such study appears to have been carried out earlier.

The set-up[3] is a conventional slow-fast scintillation assembly, using the high gain RCA 6810 A photomultiplier tubes with a $1\frac{1}{2}'' \times 1''$ NaI(Tl) crystal for the gamma detection and a well type of plastic (NE102) scintillator for the beta detection.

The isotope Tb^{160} is produced at the Bhabha Atomic Research Centre, Trombay, by irradiating natural Terbium Chloride with pile neutrons and extracting in HCl with a specific activity of 150 mc./gm. A few drops of this solution are used to prepare a sufficiently intense source of 2 mm. diameter on a thin mylar foil. The mylar foil is attached to a thin aluminium ring and is centred to an accuracy better than 1%.

Beta particles of energies above 850 keV are integrally selected with the single channel analysis in the beta channel, in order to avoid the interference due to the inner beta group of end-point energy 860 keV. The photopeak of the 86 keV gamma is selected in a sufficiently narrow window of the gamma channel. The collection of coincidence counts in this case proved to be quite difficult because of the small intensity of the transition. The false and the chance coincidences formed about 30% in this case, yielding a poor true to chance ratio. A pooled total of about 20,000 counts are collected at each angle in 22½° intervals in the range 90° to 180°. Figure 1 is a plot of the coincidence counts *versus* $\cos^2\theta$. The straight line drawn through the points is in accordance with a first forbidden beta transition. The results are fitted by method of least squares into a polynomial of the type.

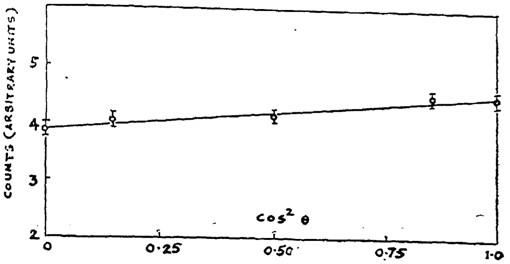

FIG. 1. Tb-160: Integral correlation plot for the 1710 keV $\beta \rightarrow$ 86 keV γ cascade.

$$W_{\beta\gamma}(\theta) = 1 + A_2\, P_2\, (\cos\theta) + A_4\, P_4\, (\cos\theta)$$

The coefficients obtained in the present case are

$$A_2 = 0\cdot096 \pm 0\cdot006$$
$$A_4 = 0\cdot003 \pm 0\cdot008$$

The coefficient A_4 is zero within experimental errors, while the coefficient A_2 is considerably large. The gamma transition being a pure $E_2(2^+ \rightarrow 0^+)$, A_4 (γ) is $-1\cdot069$ and the vanishingly small value of A_4 suggests that A_4 (β) ≈ 0. The beta transition is thus of the first forbidden type beyond doubt.

The large log ft value ($\approx 11\cdot9$) for this transition was taken as an evidence for the transition to be of the unique type in some earlier investigations[1] on the beta decay. However, in those investigations, the ground state spin of Tb^{160} was assumed to be 4^-. But it is now definitely established[2] that the spin is 3^-. The log ft value for this transition can therefore be interpreted as an evidence for the applicability of the "modified B_{ij} approximation"[4] as in the cases of several $3^- \rightarrow 2^+$ transitions. In this case, K-forbiddenness[4] appears to be the reason for the reduction in size of the normal matrix elements (of tensor rank zero and one), which enhances the log ft value, K being 3 and 0 for the ground state of Tb^{160}

and the first 2^+ state of Dy^{160} respectively ($\Delta K = 3$). A detailed analysis of this transition is beset with difficulties due to the low intesity of the beta group. It is thus very difficult to conduct the experiments on beta-gamma differential correlations and the energy dependence of the spectrum shape factor, unless the experimental techniques are improved.

The Laboratories for
Nuclear Research,
Andhra University,
Waltair, *May* 5, 1969.

V. Seshagiri Rao.
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ROTATIONAL ANALYSIS OF THE FAR ULTRAVIOLET SYSTEM OF AsO^+

Lakshman and Rao (1960) reported the vibrational analysis of a system of red degraded bands in the region λ 2550–λ 2200 and attributed it to the AsO^+ molecule. Later, Santaram and Rao (1962) studied the rotational structure of four bands 1–0, 2–0, 3–0, and 1–1 of the system excited in a heavy current discharge from a 2000 V D.C. generator. The rotational structure of the bands was photographed using a quartz littrow spectrograph with a dispersion of about 2 A/mm. at λ 2350. As each band revealed the presence of only two branches P and R, they concluded that the system arises from a $^1\Sigma$–$^1\Sigma$ transition.

The above system has been excited in a radio frequency discharge and photographed in the second order of a 21 ft. concave grating spectrograph at a dispersion of 0·62 A/mm. The structure of each of the bands 1–0, 2–0, 3–0, 4–0 and 1–1 revealed the presence of three branches P, Q and R of which the Q branch stands out prominently as the most intense. This feature strongly suggests that the system involves a $^1\Pi$–$^1\Sigma^+$ transition and not $^1\Sigma$–$^1\Sigma$ as proposed earlier.

A unique J numbering of the lines of 1–0, 2–0, 3–0. and 4–0 bands was found from a comparison of the lower state combination differences $\Delta_2 F''$ (J). Simultaneous agreement of the combination differences of the upper state $\Delta_2 F'$ (J) was also obtained for the 1–0 and 1–1 bands. The J numbering was checked by following a procedure suggested by Youngner and Winans (1960) and is shown in Fig. 1 for P, Q and R branches of part of the 1–1 band.

The rotational analysis of the five bands of AsO^+ has led to the determination of the following constants of the upper and lower states of the system as shown in Tables I and II. No Λ-type doubling could be detected in the upper $^1\Pi$ state as the combination defect is

Table I

Rotational constants B_v and D_v in the lower and upper states of AsO^+

$X^1\Sigma^+$ state		v	$A\ ^1\Pi$ state	
B_v cm.$^{-1}$	$D_v \times 10.^{-6}$ cm.$^{-1}$		B_v cm.$^{-1}$	$D_v \times 10^{-6}$ cm.$^{-1}$
$0{\cdot}518_4$	0·40	0	..	..
$0{\cdot}515_3$	0·42	1	$0{\cdot}442_0$	0·52
..	..	2	$0{\cdot}437_6$	0·53
..	..	3	$0{\cdot}432_7$	0·54
..	..	4	$0{\cdot}427_8$	0·55

Table II

Molecular constants of $X\ ^1\Sigma^+$ and $A\ ^1\Pi$ states of AsO^+

$X\ ^1\Sigma^+$ state	$A\ ^1\Pi$ state
$B_e = 0{\cdot}519_9$ cm.$^{-1}$	$B_e = 0{\cdot}449_1$ cm.$^{-1}$
$\alpha_e = 0{\cdot}0031$ cm^{-1}	$\alpha_e = 0{\cdot}004_7$ cm.$^{-1}$
$D_e = 0{\cdot}39 \times 10^{-6}$ cm.$^{-1}$	$D_e = 0{\cdot}49 \times 10^{-6}$ cm.$^{-1}$
$r_e = 1{\cdot}56_8 \times 10^{-8}$ cm.	$r_e = 1{\cdot}68_7 \times 10^{-8}$ cm.
$I_e = 53{\cdot}83_9 \times 10^{-40}$ gm. cm^2	$I_e = 62{\cdot}32_6 \times 10^{-40}$ gm. cm.^{2}
$\Delta G(\frac{1}{2}) = 1091{\cdot}32$ cm.$^{-1}$	$\omega_e = 780{\cdot}77$ cm^{-1}
	$x_e\omega_e = 7{\cdot}36$ cm.$^{-1}$

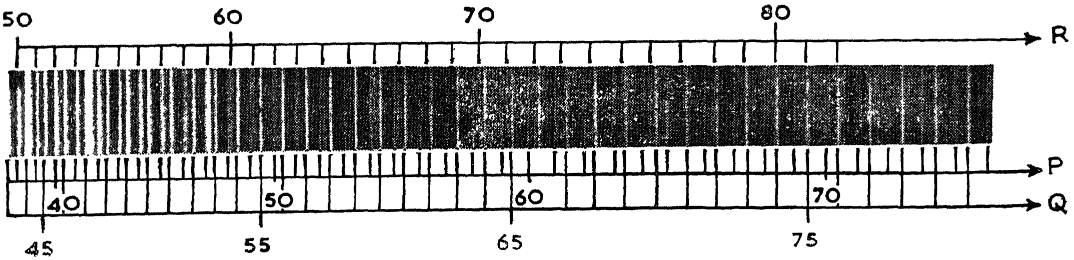

FIG. 1. Part of the rotational structure of 1–1 band of AsO^+.

found to be smaller than the accuracy of the present measurements.

The system appears to be the analogue of the $A\,^1\Pi - X\,^1\Sigma$ system of the isoelectronic molecule NO^+. The ground state $^1\Sigma^+$ of AsO^+ is attributed to $^1\Sigma$ term arising from the configuration......$(z\sigma)^2\ (y\sigma)^2\ (w\pi)^4\ (x\sigma)^2$.... $^1\Sigma^+$ while the upper $^1\Pi$ state is attributed to $^1\Pi$ term of the following configuration

.......$(z\sigma)^2\ (y\sigma)^2\ (w\pi)^4\ (x\sigma)\ (v\pi)$....... $^1\Pi$

Spectroscopy Lab.,
Dept. of Physics,
Andhra University,
Waltair, *May* 12, 1969.

D. V. K. Rao.
P. Tiruvenganna Rao.

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OXIDIMETRIC DETERMINATION OF DIMETHYLSULPHOXIDE

Dimethylsulphoxide (DMSO) finds extensive use as a solvent, antifreeze and important chemical reactant. Hence, a rapid and accurate determination of DMSO is desirable. Potassium permanganate,[1] potassium dichromate,[2] Sn(II),[3] Ti(III),[4,5] iodide[7] and chloramine-T[6] are some of the reagents recommended for the determination of DMSO. Of these, the dichromate method involves high reaction temperature and prolonged reaction period. In the present investigation, it was found that reaction conditions with dichromate could be modified such that quantitative oxidation materialised even in about a minute. It has been found that vanadate is an ineffective oxidant for the oxidation of DMSO even in the presence of catalysts.

Experimental

Reagents.—Approximately, M/20 aqueous solution of DMSO was prepared using Fluka sample and standardised by the permanganate method.[1] 0·1 N standard solutions of potassium dichromate, vanadate and ferrous ammonium sulphate were used. All other reagents used were of standard and tested purity.

Procedure.—To an aliquot volume of DMSO solution (10 ml.), is added varying amounts of concentrated sulphuric acid (10–50 ml.) and subsequently a measured excess of standard dichromate solution (20 ml.) from the burette. After mixing the contents well, it is diluted to about 200 ml. with distilled water and cooled under tap. The unreacted dichromate is estimated with ferrous ammonium sulphate using N-phenylanthranilic acid as indicator. Blank experiments were run under identical conditions without using DMSO. From the difference in the titre values of blank and test, the amount of DMSO oxidised is calculated.

Results

Results recorded in Table I show that DMSO is quantitatively oxidised to dimethylsulphone by dichromate in less than a minute when the sulphuric acid concentration of the reaction mixture before dilution is ⩾ 8 M. The heat liberated on addition of reagents and dilution of reaction mixture is sufficient to bring about instantaneous and quantitative oxidation of DMSO. The blank corrections under these conditions are very small. The method is rapid and just as accurate as the permanganate method. Results recorded in Table II indicate

Table I

Oxidation of DMSO by dichromate in strong sulphuric acid medium

m. mole of DMSO taken = 0·2938
Standing time = less than a minute

Medium	Dichromate added m. equiv.	DMSO found m. mole
4·5 M H_2SO_4 ..	2·070	0·2240
	2·070	0·2075
6·0 M ,, ..	2·070	0·2839
	2·070	0·2853
7·0 M ,, ..	2·070	0·2900
	2·070	0·2920
8·0 M ,, ..	2·070	0·2929
	2·070	0·2932
	1·553	0·2936
	1·553	0·2928
10·5 M ,, ..	2·070	0·2947
	2·070	0·2949
	1·553	0·2946
	1·553	0·2942

Table II

Oxidation of DMSO by vanadate in strong sulphuric acid medium

m. mole of DMSO taken = 0·2938
Standing time = 5 minutes
Silver sulphate catalyst used = 3 ml. (5% in concentrated H_2SO_4)

Medium	Vanadate added m equiv.	Vanadate found m. equiv.	DMSO oxidised m. mole.
4·5 M H_2SO_4	0·5323	0·5323	..
6·0 M ,, ..	0·5323	0·5323	..
7·5 M ,, ..	0·5323	0·5323	.
9·0 M ,, ..	0·5323	0·5219	0·0052
10·0 M ,, ..	0·5323	0·5167	0·0078

that DMSO is inert to vanadate at acid concentration $\leqslant$ 8 M H_2SO_4. At higher acidities, only a low amount of vanadate is consumed. Addition of catalysts such as silver sulphate, osmic acid and molybdate was of no avail. It has been observed that dichromate can be completely destroyed by excess DMSO in $\geqslant$ 6 M sulphuric acid medium. This offers a method of determining vanadate in presence of dichromate.

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Dept. of Chemistry, V. R. S. RAO.
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Madras-36, *May* 2, 1969.

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SEPARATION OF TITANIUM, ZIRCONIUM, CERIUM AND THORIUM FROM METAL IONS FORMING THIOCARBONATO-COMPLEXES WITH POTASSIUM THIOCARBONATE (PTC) REAGENT

ANALYTICAL applications of potassium thiocarbonate (PTC) reagent in the qualitative[1,2] and quantitative[3,4] analysis of metal ions have already been reported. It forms water-soluble thiocarbonato-complexes when added in excess to an aqueous or ammoniacal solution containing copper (II), arsenic (III and V), antimony (III and V), selenium (IV), tellurium (IV), molybdenum (VI) and iron (II and III). In this communication is reported, separation of titanium, zirconium, cerium and thorium taking one at a time from copper, arsenic, antimony, selenium, tellurium, molybdenum and iron present together as diverse metal ions. When an excess of PTC solution is added to an aqueous solution of the above metal ion solutions they are precipitated as hydroxides and the diverse metal ions remain in solution as soluble thiocarbonato-complexes. On adding hydrochloric acid, the thiocarbonato-complexes are decomposed into sulphides whereas the hydroxides of titanium, zirconium, cerium and thorium go into solution in hydrochloric acid. The precipitated sulphides are removed by filtration, and titanium, zirconium, cerium and thorium, collected in the filtrate, are determined gravimetrically as oxide after precipitation as oxinates. The separation can also be achieved by the addition of PTC in acidic solution when the diverse metal ions are directly precipitated as sulphides. But the precipitates obtained by the first method have better coagulating properties and hence that method is preferred.

REAGENTS AND CHEMICALS

Standard aqueous solutions of metal ions were prepared using their analytical grade (B.D.H. AnalaR or Merck; G.R.) salts. A standard 1 M PTC solution[5,6] was used.

Procedure.—To 100 ml. solution containing either titanium, zirconium, cerium or thorium (nearly 20 mg.) in presence of various amounts of diverse metal ions, added PTC (1 M) solution dropwise with constant stirring till the hydroxide precipitation of titanium, zirconium, cerium and thorium was complete. 5–10 ml. of PTC (1 M) was added in excess. Hydrochloric acid (5 N) was then added till the precipitation of diverse metal ions as sulphide was complete and the supernatant solution became colourless. The precipitate was digested on steam-bath for about 15 minutes and then it was removed by filtration through Whatman filter-paper No. 42 after thoroughly washing with water. The filtrate containing titanium, zirconium, cerium or thorium was boiled to remove hydrogen sulphide. Adjusted the volume of the filtrate so that 50 mg. of each metal ion was present per 100 ml. Added a 2% alcoholic solution of oxine dropwise till the precipitation of the oxinates was complete while maintaining a pH 4·4 to 6·0 with sodium acetate-acetic acid buffer. Digested the precipitate on a water-bath at 70° and collected by filtration through Whatman filter-paper No. 40. Washed the precipitate with warm water and ignited the dry product to constant weight. The results obtained, for different quantities of TiO_2 and ZrO_2 varying from 25·0 mg. to 100·0 mg. and for quantities of CeO_2 and ThO_2 varying from 18·0 mg. to 90·0 mg, in presence of diverse metal ions, were found to be quantitative.

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Department of Chemistry, I. P. MITTAL.
Shyam Lal College, KIRPAL SINGH.
Shahdara–Delhi, *May* 10, 1969.

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RECORD OF *KINETOSKIAS* SP. (BICELLARIELLIDAE, POLYZOA) FROM THE VISAKHAPATNAM COAST, BAY OF BENGAL

STUDIES on the bryozoa of the Visakhapatnam Coast during the past three years have revealed the existence of a rich and varied ectoproct fauna, and over 60 species have been identified so far. Interesting among the collections are a few colonies of a rare and little known genus *Kinetoskias*, members of which are distributed mostly in the Arctic and abyssal Atlantic.

The specimens from Visakhapatnam were collected from the intertidal region, mainly on the boulders at the Palm Beach. Occasionally, they were also found growing on the other polyzoan colonies like *Bugula* spp. The forms are very distinctive and attach themselves by means of root-like processes at the base. The avicularia are situated right at the tip of the zooecia. Ovicells were observed on some zooecia (Fig. 1).

The genus *Kinetoskias* Danielssen was first established in 1867[5] and to-date there are only 9 recognized species.[4] It is widely distributed in the Arctic, abyssal Atlantic and Pacific but has not been reported hitherto from the Indian Ocean, Antarctic, Mediterranean and Caribbean seas. *Kinetoskias arabiensis* Robertson[5] reported earlier from the Arabian Sea has since been considered as a synonym of *Euplozoum cirratum* (Busk) by Harmer.[1] Consequently, the present record of *Kinetoskias* from the Visakhapatnam Coast is the first from the Indian Ocean. Our specimens also do not agree with the descriptions of any of the known species and in all probability belong to a new species.

Members of this genus are supposed to have originated from the shallow-water Arctic.[3] Most of the records are from "Arctic or near Arctic localities or from the abyss"[4] where the temperatures approximate polar surface temperatures.

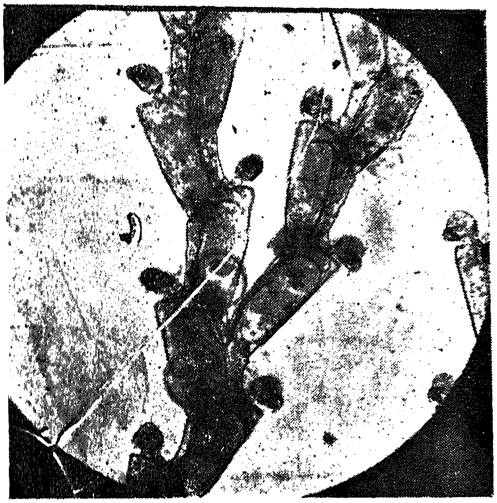

FIG. 1. *Kinetoskias* sp. from Palm Beach, Visakhapatnam Coast.

A perusal of the bathymetric distribution of this genus[2-4] shows that six out of the nine species extend up to depths of more than 2,000 metres and two of them to more than 1,000 metres. The shallowest depth at which the genus is known to occur is 30 metres (*K. arborescens*) and the deepest form (*K. cyathus*) was collected at a depth of 4,670 metres.

The occurrence of *Kinetoskias* in the intertidal region of a tropical coast during the summer months when the surface temperatures range between 28–30° C. therefore presents an interesting biological and geological problem. While it is too early to speculate on the apparent anomaly in the occurrence of the genus at a tropical intertidal locality, we suggest that a rigorous search be made for these forms at other tropical localities also.

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Dept. of Zoology, P. N. GANAPATI.
Andhra University, K. SATYANARAYANA RAO.
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UNUSUAL PERSISTENCE OF THE CORPUS LUTEUM IN THE INDIAN FRUIT-BAT, *ROUSETTUS LESCHENAULTI* (DESMARET)

ALTHOUGH the occurrence of physiological alternation of the two sides of the female genitalia in successive breeding cycles has been conclusively shown to occur in a few monotocous bats such as *Desmodus rotundus murinus* (Wimsatt and Trapido, 1952), *Taphozous longimanus* (Gopalakrishna, 1954, 1955) and *Rousettus leschenaulti* (Gopalakrishna, 1964), the mechanism by which this is brought about is not clearly understood so far. The first two above-mentioned species breed throughout the year in quick succession. *Rousettus leschenaulti* breeds twice in the year in quick succession bringing forth one young each time. In this animal the first pregnancy in the year commences in the middle of November and terminates in the middle of the following March. Within a short period after parturition the female copulates and experiences the second pregnancy in the year, and this terminates in the latter part of July. After parturition in July there is an anoestrous period which extends up to November, when the female again copulates and experiences pregnancy. Non-parous females carry their first conceptus either in the left or the right cornu of the uterus, there being no physiological dominance of one side over the other. After the first pregnancy the succeeding pregnancies invariably alternate between the two uterine cornua.

The present report is based on the examination of the ovaries of numerous specimens of *Rousettus leschenaulti* collected at frequent intervals throughout the year, and including females of various age groups. This has revealed a number of interesting features so far not known in any other animal.

In the females in their first breeding cycle ovulation occurs at random either in the right or in the left ovary. In subsequent breeding cycles ovulation alternates between the two ovaries and a single follicle ruptures each time. After ovulation the corpus luteum grows very rapidly and occupies almost the entire ovary within a short time, and remains throughout the period of gestation and persists after parturition until about the middle of the following pregnancy. Thus, in pregnant females in their second pregnancy onwards both the ovaries contain a large corpus luteum each until about mid-pregnancy; on one side the corpus luteum belongs to the current pregnancy, and on the other side it belongs to the previous pregnancy. Since, a large corpus luteum of the previous pregnancy almost completely filling the ovary is present in one ovary at the beginning of each breeding cycle, the development of the next follicle for ovulation can only occur in the opposite ovary. Such a mechanism bringing about a regular alternation of ovulation between the two ovaries in successive cycles by the protracted persistence of the corpus luteum in one ovary is not known to exist in any other animal.

One other interesting point worth recording relates to the fact that the duration of the life of the corpus luteum varies in the two pregnancy cycles. The corpus luteum of the pregnancy commencing in November persist until the following May, that is for a duratio of about 6 months, while the corpus luteu of the post-partum pregnancy, which commences in March, persists until the middle o the following January, that is, for nearly 1 months. This difference is due to the fact tha an anoestrous period of about 4 months inter venes between parturition in July and th commencement of the next pregnancy i November. In both the cases the regressio of the corpus luteum does not occur until th following pregnancy has progressed up t about mid-gestation, after which it undergoe rapid regression, and the ovary begins t produce follicles of which one ultimately develops into the Graafian follicle, which releas the ovum in the next cycle. Evidently, t regression of the corpus luteum in *Rousett leschenaulti* appears to be in some w dependant on the bearing of pregnancy in t opposite side of the genitalia.

College of Science, A. GOPALAKRISHNA.
Nagpur, Maharashtra,
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INFLUENCE OF MOULD ISOLATES FROM SORGHUM GRAIN ON VIABILITY OF THE SEED

THAT the micro-organisms carried on the seed vary quantitatively and qualitatively with plant species has been shown by several workers.[1-5] Johnson[6] reported that the activities of the seed-borne microflora cause annually a loss of 1 to 2% to world's grain produce and Nagel and Semenuik[7] and Semenuik[8] found that the activities of micro-organisms carried on the seed varied with relative humidity, temperature and oxygen concentration of the storage place. The present studies were made to examine the damage caused to the viability of sorghum seed by different externally seed-borne fungi.

Samples of sorghum seed obtained from 20 different centres were suspended in sterile distilled water and externally borne fungal flora were isolated by the serial dilution method. From out of a large number of fungi thus isolated, 20 different species of the most common ones were selected. They were multiplied in pure cultures and used in these studies. One hundred gm. quantities of sorghum seed, variety CSH-1, with 10% moisture content and 95% viability, were taken in 250 ml. Erlenmeyer flasks, surface-sterilized with 0·1% mercuric chloride for 3 minutes, washed in changes of sterile water and dried at room temperature (25° C.).

Spore suspension of the test fungus was prepared in calculated quantity of sterile water and added to the surface-sterilized seed, shaken thoroughly to provide a uniform coating of the fungus on the seed and to increase the moisture content to 18%. After the treatment the flasks were incubated at 26–28° C. for 15 days. There were triplicates under each test series. After 15 days the seeds were surface-sterilized with 0·1% mercuric chloride, washed in changes of sterile water, dried in shade and tested for viability on moist filter-paper in germination trays. There were five replications of 100 seeds under each treatment and final germination counts were taken by the end of fourth day. The data are given in Table I.

TABLE I
Influence of mould isolates from sorghum grain on viability of the seed

Test organism		% reduction in viability
Aspergillus flavus	..	80
Aspergillus niger	..	73
Aspergillus tereus	..	72
Penicillium notatum	..	78
Penicillium spiculisporum	..	65
Curvularia geniculata	..	66
Cephalosporium curtipes	..	70
Trichothecium sp.	..	50
Memnoniella sp.	..	66
Botrytis sp.	..	60
Cladosporium sp.	..	80
Helminthosporium nodulosum	..	58
Helminthosporium sp.	..	55
Fusarium oxysporum	..	48
Fusarium sp.	..	64
Alternaria sp.	..	70
Pycnidium sp.	..	38
Chætomium sp.	..	62
Mucor racemosus	..	40
Rhizopus nigricans	..	42
Control (un-inoculated)	..	25

The results indicate that the test fungi reduce viability of the seed to varying percentages, two of them upto 80%. Papavizas and Christensen[9] repored similar results in stored wheat seed with a moisture content of 14·7% to 20·0% and Armolik *et al.*[10] with stored barley seed with moisture content of 18–25%, using *Aspergillus* sp. and *Fusarium moniliforme*, respectively, as test organisms. Since the seed was treated to form a dry coat, maintaining at the same time a relatively low moisture content, there is reason to believe that whenever seeds are stored under such conditions by the farmers, severe reductions in viability of the seed will be caused by the externally borne fungi. It is therefore advisable to eliminate the external fungal flora before storing the seed for use in the following season, rather than treating it after storage and before sowing.

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Dept. of Agricultural Microbiology, K. S. NARASIMHAN.
Uuniversity of Agricultural Sciences, G. RANGASWAMI.
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CONTROL OF PADDY CUT WORMS BY DD-136, A PARASITIC NEMATODE

CUT WORMS, *viz.*, *Pseudaletia separata* Walker, the paddy cut worm and *Cirphis compta* Mo., the defoliating caterpillars which were till now of little importance have assumed the status of major pests during the past four years and were found attacking high-yielding varieties especially at the ripening stage of the earheads. Though current literature indicated the possibility of control of cut worms through insecticides (Butani,[2] Bindra and Rathore[1]), control of paddy cut worm by chemical means at a time when the crop is at maturity is difficult, as the caterpillars remain concealed inside the clump nearer the soil making the coverage impossible; it is also hazardous to control cut worms by insecticides when the grains are almost ripe, because of the possibility of residual toxicity in the grain and straw which cannot be eliminated.

Therefore, a new method of control with the help of a larval parasitic nematode DD-136 was attempted at the Central Rice Research Institute. A laboratory study was first carried out to test the effectiveness of DD-136 in the control of the above two species of cut worms. The larvæ of the two species artificially inoculated in petridishes according to the method described by Rao and Manjunath,[3] died within one to four days; infective stage nematodes emerged from the dead larvæ within a week. This indicated the suitability of DD-136 in the control of larvæ of the two species.

The encouraging laboratory results were followed by green-house experiments with rice plants infested by cut worms. Fifteen healthy and full-grown larvæ of each species of *P. separata* and *C. compta* were released on caged rice plants of variety *Padma*, and DD-136 culture solution was sprayed on foliage. In a second set of plants DD-136 was applied in standing water and a third set served as a check. The spraying was done in the evening hours. The dead larvæ were daily removed to traps for nematode emergence. The observations showed that in the case of both the species there was considerable larval mortality both in spraying and in application in standing water. Infective stage DD-136 nematodes emerged from the dead larvæ indicating the effectiveness of both the treatments.

These findings were later tested on a field scale in *Rabi* 1969 when an epidemic of both species of cut worms threatened a crop of a high-yielding hybrid strain, *CR.* 10-*4186*, evolved at Central Rice Research Institute. The field was demarcated into three subplots of equal size measuring 3·0 × 6·5 M^2 of which one was control and the other two got a spraying of either DD-136 or 0·04% insecticide Parathion. One litre of DD-136 culture solution consisting of 1,000 to 1,200 individuals per millilitre was diluted to make 2 litres of spray solution and utilised to spray the plot (2) above. After the spraying, four samples were fixed at random inside each sub plot. Each sample consisting of 12 plants was covered by field cages fixed 5 to 8 cm. below the soil.

The field cages were removed 60 hours after the spray treatment and the total population of live and dead cut worm larvæ were carefully counted by uprooting and examining the sampled plants. The dead larvæ were kept on "nematode emergence traps" and the live larvæ were reared in laboratory to observe for further mortality.

The data showed that the number of live larvæ of the two species were relatively low in DD-136 sprayed treatment (25) as compared to check (99). Under Parathion spray treatment, only four larvæ were recovered. The dead larvæ from the sprayed treatment with DD-136 gave an emergence of infective stage nematodes. Out of four samples collected there was emegence from all the four samples, It may however be pointed out that a few DD-136 nematodes could be recovered from dead larvæ from two out of four samples from the check plot also. This might be due to the migration of nematodes from sprayed to unsprayed area on the surface of the water.

The most significant point which emerges from the above laboratory and preliminary field experiments is that there is a distinct possibility of controlling cut worms' attack in the field by spraying DD-136. It may be mentioned here that other important rice pests, *viz.*, *Tryporyza incertulas*, *Chilo suppressalis*, *Sesamia inferens*, *Melanitis ismene*, *Parnara mathias*, *Cnaphalocrocis medinalis* and *Pachydiplosis oryzæ*, were also found to be susceptible to DD-136 in laboratory tests. The nematode sprays will be tried on field scale in the coming season when large-scale attack of any of the above pests is seen on the crop. To meet the large-scale requirement of DD-136, a technique for mass rearing of DD-136 on synthetic medium has also been standardised.

The authors are thankful to Dr. S. Y. Padmanabhan, Director, Central Rice Research Institute, Cuttack, and Dr. A. B. Joshi, Deputy Director-General, Indian Council of Agricultural Research, for their keen interest, advice and encouragement. Thanks are also due to Dr. V. P. Rao, Entomologist-in-Charge, Commonwealth Institute of Biological Control, Bangalore, for the supply of nucleus culture and for his advice on its maintenance.

Central Rice Research
Institute,
Cuttack, Orissa,
February 3, 1969.

P. ISRAEL.
Y. R. V. J. RAO.
P. S. PARKASA RAO.
A. VARMA.

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A NOTE ON 'ALBINO' *XANTHOMONAS*

PHYTOPATHOGENIC rod-shaped bacteria belonging to the genus *Xanthomonas*, are characterized by the possession of a particular water-insoluble carotenoid pigment which imparts a typical yellow colour to the bacterial growth.[1] But there are forms in the genus which are devoid of this pigment and are specified as achromogenic xanthomonads. These colourless xanthomonads are popularly known as 'albino' *Xanthomonas* and have been found to be pathogenic.

A yellow-pigmented bacterium was isolated from blighted leaves of a convolvulaceous weed (*Ipomoea* sp.) during August, 1967, in Delhi and was identified as *Xanthomonas uppalii* Patel.[2] The isolate was typically yellow and formed raised, smooth, circular colonies with entire margin on nutrient agar medium. The bacterium was found to be stable in its morphological traits including pigmentation even after several transfers and when maintained at 10°, 27°, 35° C. and room temperature (30–32° C.).

With a view to establish fresh cultures of the bacterium, the host plant was spray-inoculated in April, 1968 with an aqueous suspension of the bacterium prepared by transferring 48 hr.-old bacterial growth from nutrient agar slants to sterile distilled water. Ten days after inoculation, when typical lesions developed on the leaves, isolations were made on nutrient agar medium by streak plate method. After 72 hr. incubation at 27° C., about 25 well-separated bacterial colonies from the streaked plates were transferred to nutrient agar slants and incubated for growth. Typical *Xanthomonas* cultures were obtained in all the transfers except one where the culture was colourless but resembled xanthomonads in other cultural characters, *viz.*, smooth, slimy, raised growth with entire margin and without any fluorescent pigmentation. The yellow-coloured and colourless cultures of the bacterium were further purified by single colony transfers.

The chromogenic and achromogenic cultures were examined for cell morphology, Gram reaction, capsulation, spore formation and flagellation. The bacterial cells in both the cultures were rod-shaped, Gram-negative, capsulated, non-sporeforming and possessed a single polar flagellum. The colour of the cultures remained stable both when grown on different culture media—potato dextrose agar, nutrient agar, yeast glucose chalk agar and potato sucrose agar* and at different temperatures –10°, 27°, 35° C. and room temperatures.

Inoculation of the healthy host plants with yellow and white bacterial cultures, separately produced identical symptoms after the same incubation period. Isolations from the inoculated plants yielded the respective cultures. Furthermore, both chromogenic and achromogenic cultures were found to infect *Tropaeolum majus* L. which has been recently recorded as an additional host of *X. uppalii*.[3] The similarity between these two cultures was further substantiated by their identical bacteriophage susceptibility.

In morphological and pathological characteristics and bacteriophage susceptibility, the yellow and colourless bacterial cultures, were, thus, found to be identical, indicating thereby that the achromogenic ('albino') culture of the bacterium was a mutant strain of the original yellow-pigmented *Xanthomonas* and had arisen, in nature, from the latter under unknown circumstances. This constitutes the first record of an achromogenic *Xanthomonas* from India.

Since, it is evident from the present investigation that the colourless *Xanthomonas* is a mutant strain of the pigmented *Xanthomonas*, the attempt to identify the achromogenic xanthomonads as distinct species and grouping them separately under the genus *Xanthomonas*, as followed in *Bergey's Manual of Determinative Bacteriology*,[4] does not appear natural and practicable. Moreover, the recognition of achromogenic xanthomonads as a separate entity in the genus *Xanthomonas* has had created confusion in distinguishing between pseudomonads and colourless xanthomonads. The taxonomic positions of *X. rubrisubalbicans* (Christopher and Edgerton) Savulescu and *X. panici* (Elliott) Savulescu are examples of such dilemma.[5,6] The systematic validity of *X. cannae* (Bryan) Savulescu, *X. conjac* (Uyeda) Burkholder, *X. proteamaculans* (Paine and Stanfield) Burkholder, and *X. zingiberi* (Uyeda) Savulescu, the achromogenic xanthomonads of *Bergey's Manual*, has also been doubted, recently.[7]

In the light of present investigation, it is, therefore, suggested that only those non-pigmented phytopathogenic bacterial forms should be identified as achromogenic xanthomonads whose original pigmented *Xanthomonas* species are traceable in nature and such forms should, more correctly, be specified as achromogenic mutant strains of the yellow-pigmented *Xanthomonas* spp. The taxonomy of *X. manihotis* (Arthaud-Berthet) Starr, tne colourless *Xanthomonas* which has been reported to be susceptible to some of the bacteriophages of pigmented *Xanthomonas* spp.,[8] would, however, require further investigation in the light of preceding suggestion.

The author wishes to record his grateful thanks to Dr. S. P. Raychaudhuri for providing facilities and to Dr. M. M. Payak, Dr. P. N. Patel and Mr. K. Mohan for their interest in the work.

Division of Mycology and
Plant Pathology,
Plant Pathological
Sub-Station,
I.A.R.I., Flowerdale,
Simla-2, *March* 12, 1969.

J. C. DURGAPAL.

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* Composition of potato sucrose agar medium : Extract of 300 g. of potatoes, Sucrose 20 g., Peptone 2 g., KH_2PO_4 0·2 g., $Na_2HPO_4.2H_2O$ 0·5 g., $Ca(NO_3)_2$ 0·05 g., KCl 0·05 g., $FeSO_4 \cdot 7H_2O$ 0·5 g., Agar 20 g., Distilled water 1000 ml.

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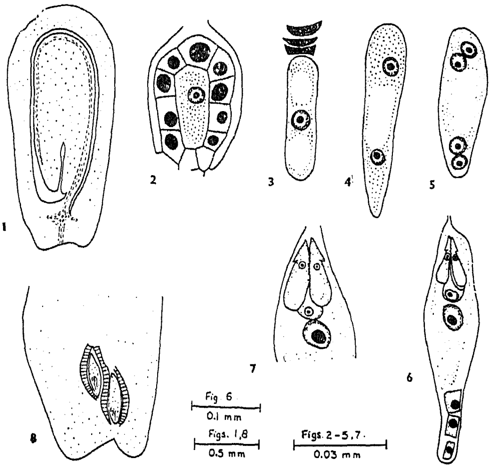
DEVELOPMENT OF THE FEMALE GAMETOPHYTE IN NIGER (*GUIZOTIA ABYSSINICA CASS*)

ALTHOUGH enough embryological literature exists in the family Compositæ still many economically important plants remain uninvestigated. From the literature it is evident that the members of this family show monosporic, bisporic and tetrasporic types of embryo-sac development.[1-3]

Guizotia abyssinica is an economically important plant noted for its oil. This crop, niger, though African in origin,[4] has been under cultivation in India for centuries. This paper deals with the development of the ovule and the female gametophyte in *Guizotia*. The capitula of niger at different stages of growth were fixed in formalin-acetic-alcohol. Usual procedure of dehydration and embedding was followed. Sections, 8–12 microns thick, were stained in safranin-fast green.

The bicarpellary, syncarpous and unilocular ovary contains a single anatropous, unitegminal and tenuinucellar ovule. The vascular supply to the ovule which consists of a single strand extends up to the micropylar end of the embryo-sac on the dorsal side of the ovule (Fig. 1).

A single archesporial cell differentiates just below the nucellar epidermis and functions directly as the megaspore mother cell (Fig. 2). After meiosis, four megaspores are formed which are arranged in a linear row. The chalazal megaspore develops further while the other three megaspore degenerate (Fig. 3). The functional megaspore now undergoes three mitotic divisions resulting in an eight-nucleate embryo-sac, whose development conforms to the Polygonum type (Figs. 4-6). The three antipodal cells are arranged in a linear row and degenerate soon after fertilisation. The two polars fuse to form the secondary nucleus which lies very close to the egg. The two synergids are hooked (Fig. 7) as is also the case in *Xanthium strumarium*[5] of the tribe Helianthoideæ. Presence of two embryo-sacs in the same ovule have been observed in one case in this plant (Fig. 8). More than fifty megaspore tetrads have been examined during the present investigation. In no case so far, any indication of bisporic or tetrasporic types of embryo-sac development have been observed.



FIGS. 1-8. Fig. 1. L.S. Ovary showing the vascular strand running around the ovule up to the micropylar end. Fig 2. Megaspore mother cell. Fig. 3. Tetrad showing the functional and the three degenerating megaspores. Fig. 4. Bi-nucleate embryo-sac. Fig 5. Four-nucleate embryo-sac. Fig 6. Mature embryo-sac. Fig. 7. Part of emryo-sac showing hooked synergids. Fig. 8. L.S part of ovule showing two embryo-sacs.

The author is thankful to Dr. R. P. Singh for helpful suggestions and to Dr. L. B. Singh, Director, for facilities.

National Botanic Gardens, SUMAN CHOPRA.
Lucknow, *February* 18, 1969.

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INDUCED MUTAGENESIS IN SORGHUM-RELATIONSHIP BETWEEN M_1 SEED STERILITY AND M_2 MUTATION FREQUENCY

IN mutation breeding programmes the relation of M_1 fertility to the mutation rate in the M_2 is of considerable importance, since this relationship will obviate some of the difficulties in fixing up the effective dose levels and in selecting M_1 plants for isolating mutants in the M_2. The present investigation was taken up with the variety Co. 11 of *Sorghum durra* of Sativa of Eu-Sorghum to study the relationship of M_1 seed fertility to the frequency of chlorophyll mutations in treatments with Nitrosoethyl urea (NEU) and Methyl methane sulphonate (MMS). The required concentrations of MMS were prepared in phosphate buffer solution at pH 7 while those of NEU treatments were prepared in water. The seeds that were pre-soaked in water for four hours were treated for eight hours with the chemicals at room temperature (27 ± 1° C.).

The frequency of M_1 plants in different doses with different percentages of seed-set and the number among them showing mutations in M_2 are presented in Table I. The fertility of M_1 plants showed a wide range in both the treatments with NEU and MMS. The fertility of mutated plants exhibited a range only beyond 50% in all the doses. The frequency of the mutated plants in the different fertility groups as shown in parenthesis would reveal that the fertility of the M_1 plants was independent of the mutation induction in each of the mutagens. This indicates the independence of M_1 plant fertility and M_2 mutation rate in Sorghum which is in conformity with the earlier reports by Gustafsson,[3] Mackey[5] and Gaul[2] in barley, Bhatia and Swaminathan[1] in wheat and Hildering[4] in tomato.

The situation was, however, found to be different when the mean seed fertility of the M_1 population per dose was computed. The comparison between the mean M_1 population

TABLE I

M_1 seed fertility and M_2 mutation frequency

Treatments (%)	Frequency distribution of seed fertility (%)						Mutation frequency (%)	
	0–20	21–40	41–60	61–80	81–100	Mean fertility %	M_1 plant basis	M_2 plant basis
Control	..	..	..	..	30	97·8	..	..
NEU 0·005	..	7	7 (1)	7	..	55·1	4·76	0·35
0·01	2	4	12	11 (2)	4	53·7	6·06	0·71
MMS 0·005	4	6	9	6 (1)	3	48·4	3·55	0·30
0·01	19	2	16 (1)	19 (2)	5 (1)	43·9	8·20	2·20

The number of mutated plants is given in parenthesis.

fertility per dose and the corresponding mutation frequency in the doses shows a steady relationship between the fertility and the mutation rate. Ramanna and Natarajan[6] and Rao and Natarajan[7] reported in barley that the decrease in M_1 population fertility closely corresponded with the increase in M_2 mutation rate suggesting a close relationship between these two phenomena. The data presented in Table I in the present study indicate the decrease in fertility of M_1 population and an increase in mutation frequency with the increasing dose of the mutagens. It is inferred that higher the mean sterility of M_1 population, higher the mutation rate, a relationship that evidently contradicts the independence of M_1 plant sterility and M_2 mutation frequency, when individual M_1 plant values alone are considered. This apparent contradiction, however, would suggest that the sterility of a population is an indication of the mutation frequency in the M_2.

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K. SREE RAMULU.
B. W. X. PONNAIYA.

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POLYMORPHISM IN THE STOMATA OF *SOLANUM NIGRUM* LINN.

DURING the course of investigations on the eco-physiological behaviour of *S. nigrum*, cases of abnormal occurrence of different sizes of stomata were observed on the dorsal (lower) surface of the mature leaf in this species. A few reports on this topic are on record for some other plants.[2-7] All these stomata were found to be ranunculaceous (anomocytic) type. In our earlier observations the stomata were partially affected as regards their sizes and distribution per unit area by the photoperiod to which the plants of this species were exposed.[6]

The plant on which polymorphic type of stomata were recorded, grew under normal conditions in the Botanic Garden of this University. The only major distinction which could be made out in the plant was that it bore purple-black berries as aginst those having orange-coloured ones. Distinction into purple-black, shiny black and orange berries as hexaploid, diploid and tetraploid forms respectively has been made.[1,8] Besides these colours, plants with yellow-coloured fruits have also been discovered by the authors.

Considering this as an abnormal occurrence from cases so far observed even in other families,[4,5] the occurrence appeared worthwhile for a recognition. The leaves selected were mature so as not to create any doubt of stomata being in initiating or developing stages. As is well known, though stomata continue to develop through a considerable part of the epidermal extension of the leaf by cell enlargement,[3] new stomata would hardly arise when a leaf has attained full maturity. Further to prove that the sizes of the stomata fall in more than one group, they were measured a random from a number of places in the lea peelings, and the same has been shown in th graph (Fig. 1). It is evident from this grapl

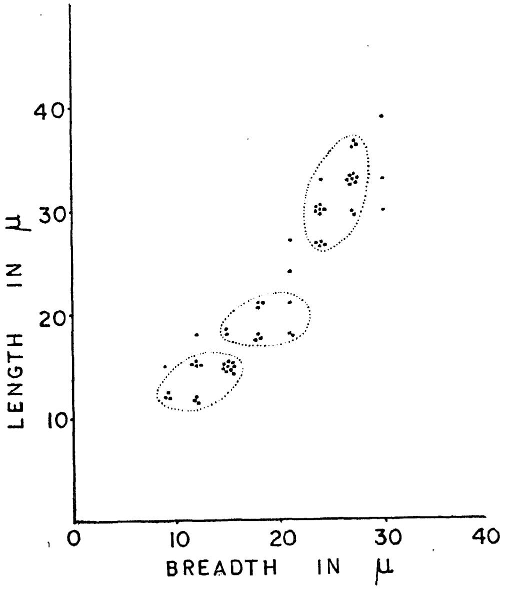

FIG. 1. Relationship of length and breadth in polymorphic stomata in the leaf peeling of *S. nigrum*.

that the stomata fell in three distinct groups: the highest number was that of largest size, the lowest of the medium size, and the smallest occurred in between these two. The means and the standard deviations, which are a measure of the scatter of the observations around means, in the three sizes of the stomata are shown in Table I.

TABLE I

The means and their standard deviations of the three sizes of stomata in the leaf peelings of S. nigrum

Length and breadth of stomata	Size of stomata		
	Small	Medium	Large
Length* ..	14±2·4	20±2·4	31±3·7
Breadth* ..	12±3·0	18±3·0	26±2·8

* All figures are in micron.

Botany Department,
University of Jodhpur,
Jodhpur (Rajasthan),
March 15, 1969.

KESHAV D. SHARMA.
DAVID N. SEN.

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TRANSFORMATION OF A BIOCHEMICALLY DEFICIENT MUTANT OF *ASPERGILLUS NIGER* VAN TIEGHEM

THE occurrence of the process of transformation in *Aspergillus niger* has been demonstrated earlier,[1] where a number of biochemically deficient mutant strains of *Aspergillus niger* were transformed to wild type by treating the conidia of the mutants with the DNA extracted from the wild type strain. In the present report, DNA from an avellaneous coloured mutant (designated U_3An_{21}) derived through UV treatment[2] of strain V_{35} of *Aspergillus niger* was used to transform an adenine deficient serpentine green mutant (designated $C_{51}Ad_1$). This mutant possessed two-step UV-induced mutations. The first mutation, a morphological one, was from V_{35} (black-coloured conidia) to serpentine green-coloured conidia (C_{51}), and the second mutation was the biochemical mutation[3] (Ad_1) leading to the dependence of the strain C_{51} to adenine.

Conidia of the recipient strain $C_{51}Ad_1$ were treated[1] with the DNA (25 μg./ml.) from the donor strain U_3An_{21} for 20 hours at 30° C. in minimal medium,[4] after which the transformation reaction was terminated by the addition of DNase ($2 \cdot 0 \times 10^{-3}$ μg./ml.) and further incubation for half an hour. The conidia were then plated on minimal medium to score the number of transformants to adenine independence. The results are given in Table I.

TABLE I

Transformation of conidia of $C_{51}Ad_1$ strain (Serpentine green conidia and adenine−) by DNA from U_3An_{21} strain (Avellaneous conidia and adenine+)

Number of Conidia treated with the donor DNA	Number of transformants to adenine independence		Per cent transformants	
	A Avellaneous (U_3An_{21} type)	B Serpentine green (C_{51} type)	A	B
$5 \cdot 0 \times 10^6$	8	304	$1 \cdot 6 \times 10^{-4}$	$6 \cdot 0 \times 10^{-3}$

No transformants or colonies of the above types were observed, when the same number of conidia ($5 \cdot 0 \times 10^6$) were plated after treatment with the DNA from the recipient strain or plated without DNA treatments.

Majority of the transformants were of the green type where the gene responsible for adenine deficiency had been transformed to adenine independence, in this case only one transformation reaction had taken place, *i.e.*, ad⁻ became ad⁺. The avellaneous transformants were either due to two transformation reactions leading to the change in two genetical functions or integration of a larger part of the DNA molecule which carried two markers, one for the conidial colour (Avellaneous) and the other for adenine independence (ad+). If the latter be true then both markers (Avellaneous and ad+) are on the same molecule of the DNA. All the transformants have bred true for successive generations.

Dept. of Microbiology, A. K. Mishra.
Bose Institute, K. Sen.
93/1, Acharya P.C. Road,
Calcutta-9, India, *April* 25, 1969.

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THERMAL ADAPTATION OF PHOTOSYNTHESIS IN TWO ALGAL STRAINS

Temperature responses of synchronised *Chlorella* and *Pseudochlorella* cells have been obtained under treatments such as periodic 12/12-hours' light/dark, aerating the suspension with air and 2%-CO_2 (10). *Chlorella* 211/8K,—the "high-temperature" strain of Sorokin (1959) and *Pseudochlorella pyrenoidosa* (Zeitler) Lund (1955), the "low-temperature" strain have been selected. Both the strains have a wide range of potentiality in photosynthetic activities influenced by experimental factors: light, time or period of illumination and temperature.

The cells were harvested after steady attainment of synchrony and then set into experimental adaptation to temperature coupled by same intensity (20 Kilolux) of light, at 15°, 25°, 30° and 35° C. for 28 hours. The rate of photosynthesis towards oxygen-evolution has been measured electrochemically at: 10, (15), 20, 30 and 35° in 20 Kilolux from each adapted harvest.

Results.—Figures 1 and 2 represent the two 'reaction norms' of photosynthetic-O_2 evolution of the two algal strains. *Pseudochlorella*: The 15°-cells show much higher rates of photosynthetic-O_2 escape measured at 10° to 20° (Fig. 1), but when measured at 30°, the rate falls to about 1/3 of the highest value and at 35° there is no measurable photosynthetic-O_2 evolution. The 25- and 30°-cells show lower rates but measured at 30 and 35° they are able to evolve higher photosynthetic-O_2 at 35° the 30°-cells show about 50% of the highest value, whereas it is practically *zero* for the 15°-cells. In addition it is noted that

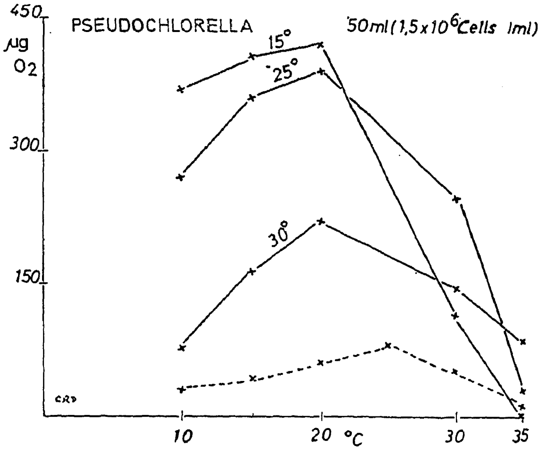

FIG. 1. *Pseudochlorella.* Dependence of maximum photosynthesis on temperature in relation to harvest-temperatures. Light intensity 20 Kilolux. Harvest-temperatures 15, 25 and 30°. For comparison with harvest on Agar-slopes at room temperature : (× ---- × ---- ×).

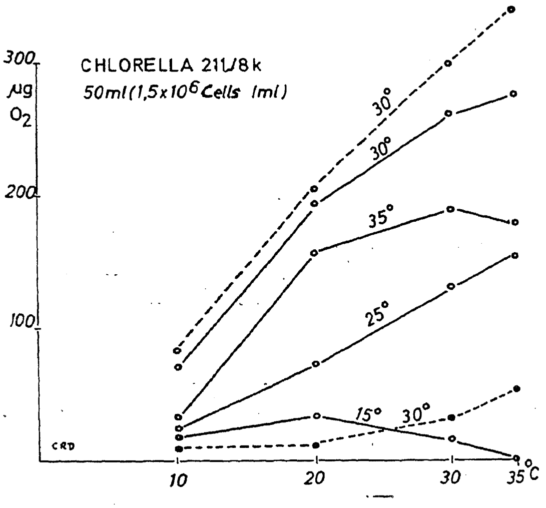

FIG. 2. *Chlorella* 211/8 K. Same as in Fig 1. Harvest-temperatures 15, 25, 30 and 35°. Dark respiration of 30° cultures (with negative) ordinate values (● --- ● --- ●). Also absolute photosynthesis at 30° (○ --- ○ --- ○) shown.

the photosynthetic rate from the cells actively growing on solid agar-mineral medium at room-temperature (25–28°) shows the values all lying below the other values measured at the entire range of temperatures, but measured at 35° a positive balance in O_2-escape has been observed to contrast these cells with the 15°-cells. It seems, therefore, that an *extra-factor* here tends to interfere in the cells grown on solid agar-mineral medium upon the capacity of the cells for the photosynthetic-O_2 evolution. But for more accurate understanding of the cellular reactions, harvests on defined liquid-mineral media (Kuhl and Lorenzen, 1964) have been selected for further analytical purposes.

Chlorella 211/8 K.—The study with this so-called 'high-temperature'-strain illustrates another representation by the *curve-series* (Fig. 2). The 15°-cells are able to show positive balances of photosynthetic-O_2 evolution when measured at 10°, 20° over to 30° and down at 35° to *zero* where practically *no* O_2-escape is observable. The 25°-cells show advancing rate of photosynthesis with increasing temperatures of measurement. All higher values can be obtained from the 30°-cells, even more than those obtained from 35°– or 25°–cells. The absolute photosynthetic rate has been determined for the 30°-cells by accounting the respiratory O_2-intake measured at 15°, 25°, 30° and 35° directly in dark. The absolute-rate curve has the trend of giving an ideal straight line.

It follows therefore that, on the basis of endogenous respiratory role certain control over the *norms* of light reactions may be explained, but that is only for the 30°-cells and not for other instances, and that too for *Chlorella* 211/8 K only. As such it is expected that apart from respiratory influence there must be some other controlling regulatory mechanism to explain the temperature-reactions coupled by light in establishing the photosynthetic-'reaction norm' for the autotropic green cells [*vide* Das, 1968 for cellular RNA/DNA-level in relation to temperature coupled by light reactions and also Das (1968), *The Nucleus*, 2 (2), 152–154].

Two algæ as two physio-ecological extreme strains have illustrated in the present investigation, the bimodal pattern of energy efficiencies forming the 'Reaction Norm' towards O_2-evolutions. An amplitude acquired for such experimental procedure is sufficiently wide in algal photosynthesis, so that it is possible to obtain cellular analysis for accurate determination of the autotrophic mode of algal-life. Gross and Jahn (1962) have postulated a new-enzyme-protein formation under thermal stresses in *Euglena* and *Chlamydomonas*.

In *Chlorella vulgaris*, an equilibrium between photochemical and enzymatic parts of the photosynthetic mechanism on the ecocellular level seems important (Steemann-Nielsen, 1962). Jorgensen and Steemann-Nielsen (1965) have further shown that the rate of photosynthesis, as function of light-intensity, may differ during adaptation to new condition in plankton algæ.

The author wishes to express his sincere gratitude to the German Academic Exchanges (German Government) for the financial grant in finishing the doctoral thesis, 1966 from the University of Goettingen, of which this paper is a part.

Faculty of Science/Botany, C. R. Das.
Kalyani University,
Kalyani (W. Bengal), *March* 5, 1969.

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POST-INFECTION CHANGES IN ASCORBIC ACID CONTENT OF TOMATO FRUITS CAUSED BY *DRECHSLERA AUSTRALIENSE*

'Red Current' variety of tomato fruits of the same age (just ripe) were inoculated with *Drechslera australiense* (Bugn.) Subram. and Jain[1] and were inoculated at 25° ± 1° C. Injury method as suggested by Kapoor[2] was used for inoculation. The ascorbic acid content of the inoculated and uninoculated fruits was determined on every alternate day. For this purpose 2 g. of the pulp from the healthy/diseased fruit was separately crushed with 25 ml. of metaphosphoric acid in a ground-glass homogenizer and filtered. The residue was washed twice using 10 ml. of 5% metaphosphoric acid each time. The volume of the total filtrate was then finally raised to 50 ml. The filtrate was titrated against previously standardized 2, 6-dichlorophenolindophenol reagent as recommended by Bessey and King[3] and the quantity of the free ascorbic acid in different samples was calculated. The results are shown in Table I.

TABLE I

Ascorbic acid content (in mg./100 g. fresh weight of the fruit pulp) of healthy and D. australiense *infected fruits of tomato*

	Ascorbic acid content						% of loss in ascorbic acid after 10 days of incubation
	Days of incubation						
	0	2	4	6	8	10	
Healthy	25·0	26·9	30·1	27·6	22·9	19·1	23·6
Infected	..	25·7	13·2	11·1	2·3	0·48	98·1

An increase of ascorbic acid content in healthy tomato fruits is evident upto 4 days of incubation, after which it gradually declines. Ghosh *et al.*[4] and Srivastava and Tandon[5] reported similar decline in ascorbic acid contents of healthy guava fruits in storage, although the rate of this decrease was slow as compared to that in infected fruit tissue. In the present study the ascorbic acid content of the diseased fruit tissue decreased from the beginning of incubation.

It is known that L-ascorbic acid is easily oxidized to dehydro-L-ascorbic acid by certain oxidative enzymes like ascorbic acid oxidase, polyphenol oxidase, cytochrome oxidase, peroxidase, etc. According to Fruton and Simmonds[6] the dehydroascorbic acid formed is unstable and is readily converted to the diketo-form (2, 3-diketogluconic acid). Mandels[7] reported an atypical ascorbic acid oxidase for L-ascorbic acid in certain fungi. Kirlay and Farkas[8] observed similar oxidation of ascorbic acid during fungal infection in case of rusts. It, therefore, appears that the decline in the ascorbic acid content of tomato fruit tissue infected with *D. australiense* may be due to the production of suitable ascorbic acid degenerating enzymes, either by the fungus itself or by the "host-pathogen complex".

The authors are thankful to the University Grants Commission, New Delhi, for the award of a Junior Research Fellowship to I. J. K. and to the C.S.I.R. for financial assistance to R. N. T.

Department of Botany,
Allahabad University,
Allahabad (India),
March 28, 1969.

I. J. KAPOOR.
R. N. TANDON.

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REVIEWS AND NOTICES OF BOOKS

Perspectives in Phytochemistry. Edited by J. B. Harborne and T. Swain. [Academic Press, Inc. (London), Ltd., Berkeley Square House, London WIX 6BA], 1969. Pp. xi + 235. Price 63 *sh.* or $ 9.00.

This book contains review papers presented at the Tenth Anniversary Meeting of the Phytochemical Society held in April 1968. The meeting was organized to provide a broad perspective of developments in phytochemistry during the past ten years, and all the major aspects of the subject are covered by the leading authorities in their respective fields.

An introductory chapter, indicating the importance of spectroscopic methods in structural elucidation of natural plant constituents, is illustrated by reference to the flavonoid pigments. Then follow three chapters outlining the most recent developments in the biosynthesis of cyanogenic glycosides, carotenoids, triterpenes and fatty acids. The next four chapters are devoted to molecular taxonomy, another very active area of phytochemical research; there are two broad review chapters, followed by more detailed accounts of the chemotaxonomy of the Compositæ and the Monocotyledons. The importance of metabolic and functional studies has not been neglected; the two final chapters deal with the metabolism of phenolics in the fungi and the role of flavonoids in controlling the growth of higher plants. Such is the rate of growth of phytochemistry that this is the last time it will be possible to consider all the various aspects of the subject within a single volume. The broad scope of this book, the novel material presented in many of the chapters, and the authority and distinction of the various contributors should guarantee its appeal to all those interested in phytochemistry, be they organic chemists, biochemists or botanists. C. V. R.

The Chemical Bond : A Brief Introduction to Modern Structural Chemistry. By Linus Pauling. (Cornell University Press, Ithaca, New York and London : Oxford University Press), 1967. Pp. xi + 267. Price 22 *sh.* 6 *d.* net (in U.K. only).

Like the renowned parent volume—*The Nature of the Chemical Bond*—this abridged version provides a general, essentially non-mathematical treatment of present knowledge about the structure of molecules and crystals and the nature of the chemical bond.

The entire book has been carefully simplified by Dr. Pauling to focus sharply upon material that is pertinent to beginning students. The author has also added exercises at the end of each chapter—117 in all—and in an important new section he discusses the molecular-orbital description of the electronic structure of molecules.

The contents of this book are : 1. Resonance and the Chemical Bond; 2. The Electronic Structure of Atoms and the Formal Rules for the Formation of Covalent Bonds; 3. The Partial Ionic Character of Covalent Bonds and the Relative Electronegativity of Atoms; 4. The Directed Covalent Bond; Bond Strengths and Bond Angles; 5. Complex Bond Orbitals; The Magnetic Criterion for Bond Type; 6. The Resonance of Molecules among Several Valence-Bond Structures; 7. Interatomic Distances and Their Relation to the Structure of Molecules and Crystals; 8. Types of Resonance in Molecules; 9. The Structure of Molecules and Complex Ions Involving Bonds with Partial Double-Bond Character; 10. The One-Electron Bond and the Three-Electron Bond; Electron-deficient Substances; 11. The Metallic Bond; and 12. The Hydrogen Bond. C. V. R.

Music of the Spheres : The Material Universe —From Atom to Quasar, Simply Explained (in two volumes). By Guy Murchie. (Dover Publications, Inc., New York), 1967. Pp. xx + 644 (for two volumes together). Price $ 2.00 each.

Vol. I—*The Macrocosm : Planets, Stars, Galaxies, Cosmology.*

Vol. II—*The Microcosm : Matter, Atoms, Waves, Radiation, Relativity.*

Beginning with the solar system and reaching all the way to the dividing line between matter and non-matter, this popular-level account of our material universe explains with remarkable clarity a vast range of the latest scientific understandings. Newly revised to incorporate ideas and implications that have emerged since its original publication (1961), it is a book that should be of great interest to all readers who are curious about nature's secrets.

Volume I—*The Macrocosm*: *Planets, Stars, Galaxies, Cosmology,* ranges over the creation of mountains and oceans on Earth, Earth's environment and atmosphere, the history of flight and space travel, the lunar surface, Saturn's rings, planetary motion, Brahe and Kepler, meteorites and comets, foreign galaxies, new celestial discoveries and other topics of astronomy.

Volume II—*The Microcosm*: *Matter, Atoms, Waves, Radiation, Relativity,* deals equally well with molecular forces, Lavoisier, Mendeleyev and the elements, chemical action, heat, crystals, Descartes, Newton's laws, mesons, nuclear energy, the quantum, electricity and magnetism, the physics of music, light and color, X-rays, probability, antimatter and antigravity, calendars and clocks, Einstein and the repercussions of relativity theory, the fourth dimension, space-time, and other topics in physics and chemistry. C. V. R.

Directory of Scientific Instruments and Components Manufactured in India. [Printed and published by the Central Scientific Instruments Organization (CSIO), Sector 30, Chandigarh 20, India], Pp. xxxiv + 512 + 90 + 56. Price Rs. 30·00.

This well-got-up and massive publication of a total of more than 700 pages is a comprehensive guide book on India's production in the field of scientific instrumentation. Since the country's Independence and in the light of the avowed policy of the Government that efforts should be made for the maximum possible use of indigenous materials in manufacture, the instrument industry in India has been rapidly growing although it must be admitted that the rate of development is far from adequate to meet the demand, especially for quality instruments, of the ever-growing number of colleges and research and technological establishments. It may be noted that the Central Scientific Instruments Organization was set up under the CSIR for promoting the cause of instrument industry in the country. By this publication the CSIO has done a service to both the instruments manufacturers and the users of instruments.

The *Directory* is in three parts. Part A, of 512 pages, gives a classified list of instruments and components under sections Optical, Electrical and Electronic, Mechanical and Miscellaneous. Part B, of 90 pages, gives the names and addresses of the manufacturers. Part C is devoted to advertisements and manufacturers' announcements.

There is no doubt that the *Directory* will be of great value to science and engineering colleges, University departments of science, and research institutions in science and technology. A. S. G.

Molecular Photochemistry (Vol. 1, No. 1). Editor: A. A. Lamola, Bell Telephone Laboratories. (Published by Marcel Dekker, Inc., 97, Madison Avenue, New York, N.Y. 10016), January 1969. Pp. 160. Annual Subscription $ 35.00, Foreign Postage $ 2.00.

Molecular Photochemistry is a new quarterly Journal devoted to original and fundamental researches on different aspects of photochemistry such as mechanisms of photochemical processes, structure-reactivity relationships, spectral-reactivity relationships, structures of molecules in excited states, radiationless processes, electronic energy transfers, etc. The emphasis is necessarily on excited states.

Besides the main articles, the journal provides space for Research Notes, Letters to the Editor, Highlights in the literature of photochemistry during the past six months, and Bibliography of recent books and Review Articles on photochemistry. A. S. G.

Books Received

Lunar Atlas. Edited by Dinsmore Alter. (Dover Publications, Inc., 180, Varick Street, New York 10014), 1968. Pp. x + 343. Price $ 5.00.

Carnegie Institution of Washington. (Year Book 67). (Carnegie Institution of Washington, 1550, P. Street, N.W. Washington, D.C. 20005), 1967-68. Pp. xi + 609. Price not given.

Handbook of Fern Gardening. By P. Kachroo. (Indian Council of Agricultural Research, Krishi Bhavan, New Delhi), 1968. Pp. 37. Price Rs. 3·00.

A Treatise on Physical Chemistry (in two volumes) (3rd Edition). Vol. I: *Atomistics and Thermodynamics*; Vol. II: *States of Matter.* Edited by H. S. Taylor and S. Glasstone. (Affiliated East West Press P. Ltd., C 57, Defence Colony, New Delhi-3), 1969. Pp. vii + 679. Price Rs. 20·00; Pp. v + 701. Price Rs. 22·00.

1346-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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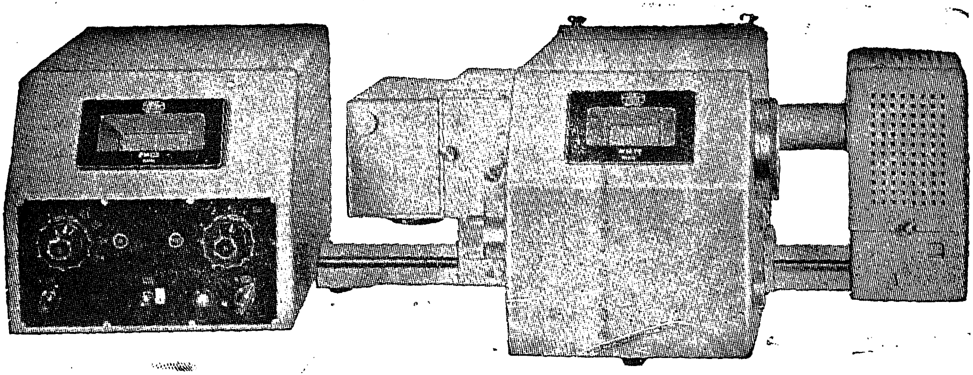

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ADVANCES IN RADIATION PLANT BREEDING

REPORTS indicating that the method of inducing mutations in plants by radiation is making an important contribution to plant breeding were given at a symposium organized by the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization of the United Nations (FAO) held in Pullman, Washington, USA, from 14 to 18 July 1969.

It was shown that at least 65 new varieties of plants evolved by the method have now been released to growers (though many others are expected soon), nearly 40 of them during the past five years. They include rice and wheat varieties with improved qualities of resistance to disease and weather, higher protein content and increased yield. Economic gains have been made in producing castor-oil in India and peppermint, the yield of which had been seriously threatened, in USA. An interesting, and commercially valuable, aspect has been the successful introduction of the technique into breeding ornamental plants.

Practical demonstrations of results obtained were provided by Washington State University, where the symposium was held. A large variety of plants bred by the method had been grown and were on view in the grounds.

Dr. Björn Sigurbjörnsson, of the FAO/IAEA Joint Division of Atomic Energy in Food and Agriculture, spoke of the progress made in the five years since the last symposium on the subject. At that time many doubts were expressed, but now success had been achieved. The efforts of dedicated scientists over four decades were now paying off in millions of hectares of superior crops throughout the world. He quoted as examples the highest-yielding rice variety in Japan, Reimei, a mutant which succeeded in competition with varieties resulting from the most intensive conventional breeding efforts. Doubling of the protein content of rice, which had been reported, also indicated the potential of the method for quality improvements.

The recent shortening by three weeks of the growing period of rice in Hungary of a neutron-induced mutant could have far-reaching effects on the extent of rice cultivation in Europe.

Mutant varieties of durum wheat had shown superior performance in trials in more than a score of countries in Asia, Africa and Europe. The FAO was recommending that some countries replace their entire wheat acreage with the new mutants.

Ingenious applications had, he said, successfully adapted one of the high-yielding Mexican dwarf wheats to local preferences in India, drastically speeding up acceptance by Indian consumers.

Mutation breeding had made a great contribution to the breakthrough called the Green Revolution, which had alleviated the problem of providing enough high-quality food to keep pace with the population growth. More important, it had drawn attention to the significance of plant breeding and the number of characteristics of high-yielding varieties which needed improvement. This was a role for which induced mutations were especially suited.

M. S. Swaminathan (India), one of the world leaders in the work, drew attention to a problem in growing castor-oil seeds which had severely affected growers. This was that it took 270 days to mature and thus was at the mercy of changes in the rainy season. As a result of inducing mutants by radiation a new variety had been evolved maturing in 120 days and was now being grown by farmers. They were now assured of a good crop every year. In addition the soil used was released for an extra 150 days for other crops such as rice, of which some varieties mature also in 120 days.

First positive results of applying the method to maize were reported by C. O. Gardner (USA), who said that yield might possibly be increased beyond the highest yet known. This could be the most important development with maize since the 1920's and was the first example of using the method effectively on open-pollinated, rather than self-pollinating, crops.

One of the best-known flavours in the world, peppermint, might have been lost but for use of the radiation method to develop resistance against disease. M. J. Murray (USA) reported that after fourteen years of fighting against a disease which could destroy whole crops it was found that use of radiation to produce plants to resist it was the only possible solution. Other methods had produced plants which resisted the disease but altered the flavour to spearmint. Use of the radiation method had saved an extremely important market.

New varieties listed, according to information available to the FAO/IAEA Joint Division up to 1 July 1969, are in types of bread and durum wheat, barley, oats, rice, soybean, peas, beans, peanuts, rape, mustard, tobacco, peach, and a number of flowers. The countries where they have been developed are Argentina, Austria, China, Czechoslovakia, India, Indonesia, Italy, Japan, the Netherlands, Sweden, USSR, UK and USA.—[*Courtesy*: International Atomic Energy Agency.]

METABOLISM OF *p*-COUMARIC ACID BY *STREPTOMYCES*—FORMATION OF CAFFEIC ACID AS INTERMEDIATE

A. M. D. NAMBUDIRI, P. V. SUBBA RAO AND J. V. BHAT

Microbiology & Pharmacology Laboratory, and Biochemistry Department, Indian Institute of Science, Bangalore-12

p-COUMARIC acid (4-hydroxy cinnamic acid) is regarded as an important aromatic compound involved in the biosynthesis of lignin in higher plants.[1,2] This compound has been reported to be an intermediate in the metabolism of tyrosine by basidiomycete fungi.[3] This communication outlines the hitherto unknown metabolism of *p*-coumaric acid by a strain of *Streptomyces nigrifaciens*.

The organism was isolated in this laboratory by enrichment culture from soil and was maintained on agar slopes containing malt extract (3%), peptone (0·5%), yeast extract (0·1%) and agar (1·5%). Cells grown on liquid medium of the same composition, without agar, were used in metabolic studies with the substrates.

Washed cells suspended in 100 ml. of 0·01 M sodium phosphate buffer, pH 7 containing 50 mg. of *p*-coumaric or caffeic acid were incubated at room temperature (25–28° C.) on a shaker. Samples (10 ml.) were drawn at 6 hr. intervals and the phenolic acids were extracted in ether (X3) after acidifying to pH 2. After removing the solvent, the residue was taken in 1 ml. ethyl acetate and the metabolites were identified by paper chromatography.[4-6] The identity of the compounds were further confirmed by comparing the u.v. spectra with those of the authentic samples.

On incubation with *p*-coumaric acid, caffeic acid was identified as the major intermediate. On prolonged incubation for more than 24 hr. traces of protocatechuic acid was also detected on the chromatogram. One compound which gave a pink spot turning violet on spraying with diazotized *p*-nitroaniline and moving almost with the solvent front (rf. 0·77) in formic acid-water (1 : 49) could not be identified. When caffeic acid was the substrate, the medium contained protocatechuic acid in detectable amounts.

It is apparent from the above results that *S. nigrifaciens* first hydroxylates the aromatic ring of *p*-coumaric acid to form caffeic acid which is further *β*-oxidized yielding protocatechuic acid. Though the conversion of *p*-coumaric acid to caffeic acid is common in plants,[2,7] it is rarely met with in micro-organisms. Reduction of the double bond in the side-chain of *p*-coumaric acid was observed by Whiting and Carr[8] with *Lactobacillus pastorianum* var. *quinicus*, though according to Finkle *et al.*,[9] *Aerobacter* sp. anaerobically decarboxylated the compound resulting in the formation of the corresponding styrine. Fungi, in general, oxidize the propane side-chain first to form *p*-hydroxybenzoic acid and this in its turn gets hydroxylated to form protocatechuic acid.[3,10] However, the initial hydroxylation of the aromatic ring of *p*-coumaric acid leaving the side chain intact by *S. nigrifaciens* is similar to the observation made by Power *et al.*[11] with the fungus *Lentinus lepideus*, though the further conversion of caffeic acid by this organism is not known. Detailed investigations on this species will be reported elsewhere.

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THE ROLE OF ATTRACTIVE JUNCTIONS IN STRAIN HARDENING OF ALUMINIUM AS SHOWN BY CHANGE-IN-STRESS-CREEP EXPERIMENTS

Y. V. R. K. PRASAD, D. H. SASTRY AND K. I. VASU

Materials Research Group, Department of Metallurgy, Indian Institute of Science, Bangalore-12

ABSTRACT

The activation volume in aluminium evaluated from data on stress increments during differential-stress creep experiments is found to be different from that of stress decrements. This is interpreted in terms of the change, on stress decrement, in the number of dislocations that are likely to get activated as a result of the full formation of attractive junctions. The effect of stress on this phenomenon is discussed.

INTRODUCTION

A STRUCTURAL theory was suggested[1] in terms of a dislocation model involving the intersection of glide and forest dislocations to explain logarithmic creep in f.c.c. metals and was supported by later investigations.[2-4] Many investigations[5,6] showed that logarithmic creep can be considered as a process of strain hardening and in fact it was used as an indirect method to study the nature of interactions between dislocations during strain hardening in f.c.c. metals. The relation between strain hardening and logarithmic creep has been discussed extensively.[7] The aim of the present investigation is to shed more light on the interactions occurring during strain hardening from a study of the logarithmic creep behaviour involving change-in-stress-creep experiments. The data from such experiments are often used to estimate the activation volume, v, for the thermally activated deformation process since,

$$v = \frac{\partial \ln \dot{\epsilon}}{\partial \tau} kT \approx \frac{\Delta \ln \dot{\epsilon}}{\Delta \tau} kT$$

where $\dot{\epsilon}$ is the creep rate, τ the applied shear stress, k the Boltzmann's constant and T the absolute temperature. Shear stress is calculated from the applied tensile stress, σ, by assuming that $\tau = \sigma/2$.

EXPERIMENTAL

Aluminium of 99·997% purity was used in the present work. The specimens in the sheet form were tested on a tensile creep-testing unit described elsewhere.[8] The testing temperature was 87° K. which was obtained by surrounding the sample with liquid oxygen. The creep-testing procedure consisted of recording the creep strain at various stress levels following increments and decrements of stress at each stress level. The accuracy of the strain measurement was 10^{-5}. Creep tests were also conducted on cadmium, a c.p.h. metal, for the sake of comparison.

RESULTS AND DISCUSSION

Figure 1 shows the typical variation of creep rate with changes in stress for aluminium.

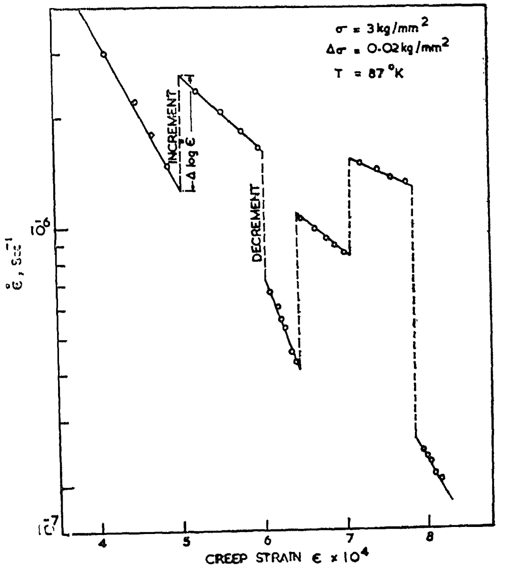

FIG. 1. Change of creep rate. $\dot{\epsilon}$, with creep strain after stress increment and decrement in aluminium.

The major observation is that the magnitude of the change in creep rate after increment following an increment is less than that observed after a decrement following an increment. Even the creep curve corresponding to the initial load can be considered as similar to that after increment since the incremental creep curve can be made to coincide with the initial creep curve by shifting it along the time axis.[6]

In fact the values of $\triangle\ ln\ \dot{\epsilon}$ corresponding to decrements should probably be more accurate for the calculation of activation volume than those for increments of stress since the creep rate will be infinitely high just after an increment (as the activation stress which is equal to the difference between the "yield stress" and the applied stress will be very low) and will fall down considerably by the time we make a measurement. However, after decrement, complications may be introduced due to strong elastic interactions between glide and forest dislocations. As a result, after the stress decrements, attractive junctions can form fully[7,9] and for certain orientations, the junctions, which would have been broken by thermal activation forming jogs, may no more be thermally activated after decrement. Thus the number of dislocations that are likely to get activated may change.

Let n represent the number of elements requiring an activation energy U for their movement and suppose the n-U distribution curve at the start of the creep is as shown in Fig. 2, the hatched area giving the number of dislocations that are likely to get thermally activated at any instant. As creep proceeds, strain hardening occurs and the whole curve will move to right. It does not seem probable that the shape of the curve changes much. After a stress increment, the activation stress, which is approximately proportional to thermal activation energy, is decreased and the curve is moved to left and we may get a very similar distribution as was existing earlier.[6] After a decrement, however, the number of elements that are likely to get activated decreases since, as a result of the full formation of attractive junctions, the number of junctions at which jogs are formed will be less. This changes the shape of n-U curve as shown in Fig. 2. Thus the change in creep rate following a stress decrement, $\triangle\tau$, is given by:

$$\frac{\delta\ ln\ \dot{\epsilon}}{\delta\tau} = \frac{v}{kT} + \frac{\delta\ ln\ \mathrm{P}}{\delta\tau} - \frac{\delta\ \mathrm{U}_0}{\delta\tau} \qquad (1)$$

where P = frequency factor (involving the number of elements per unit volume getting activated, the area slipped during an activation event, the Burgers vector and the frequency of vibration of the dislocation line) and U_0 is the total energy of activation. The difference in the values of $\triangle\ ln\ \dot{\epsilon}$ after increment and decrement is due to the term $\delta\ ln\ \mathrm{P}/\delta\tau$ since the other terms on the right-hand side of Eqn. (1) are likely to change to the same extent both after increment and decrement. This difference in the activation volume was found to decrease with stress to the extent of about 5% deformation and is negligible upto about 7% strain beyond which the nature of creep is no more logarithmic. The effect of stress may be due to the fact that the length of the attractive junctions formed will decrease with stress[9] and hence some of the junctions can be thermally activated. Also the change in the creep rate must not be very much different from that observed in the case of increments if we make a decrement after a decrement. This was not possible with our existing recording system and hence was not done.

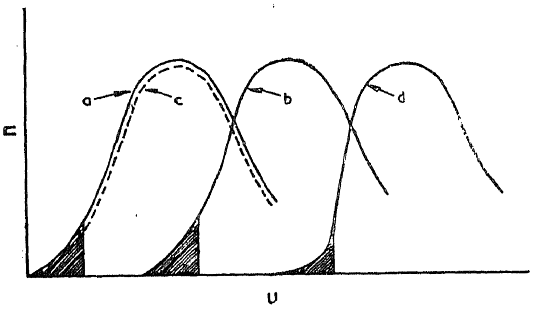

FIG. 2. Schematic representation of the probable n-U relation during creep: (a) at the start of the creep; (b) after some creep strain; (c) immediately after a stress increment is made; (d) after a stress decrement is made.

As seen in Fig. 3, the above effect is conspicuously absent in the tests conducted on

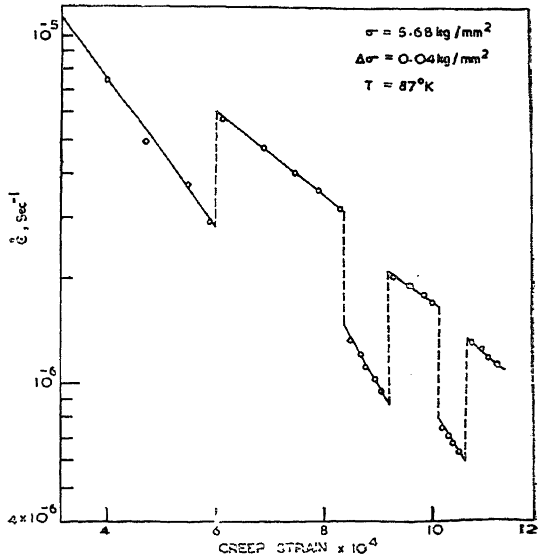

FIG. 3. Change in creep rate, $\dot{\epsilon}$, with creep strain after stress increment and decrement in cadmium.

cadmium, a c.p.h. metal, in which the local interactions between glide and forest dislocations are supposedly absent.[9] This is true even for magnesium as shown by the data of Conrad *et al.*[11]

Thus it can be concluded that the local interactions between glide and forest dislocations forming junctions may paly a significant role in the process of strain hardening in aluminium.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. S. Dhawan, Director, Indian Institute of Science, and Professor A. A. Krishnan for their interest in this work and to other members of the Materials Research Group for their co-operation. Authors are particularly thankful to Dr. G. R. Piercy, Atomic Energy Ltd., Canada, for helpful discussions.

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ON THE GROWTH OF ZINC MONOCRYSTALS FROM THE VAPOUR PHASE

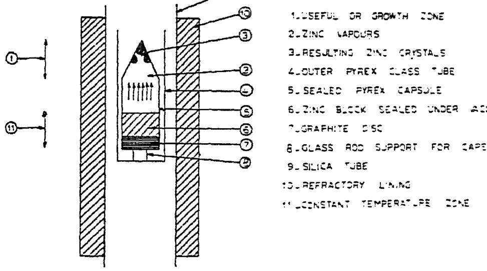
A. S. THATTEY AND SUBHASH RISBUD

Department of Metallurgical Engineering, Indian Institute of Technology, Powai, Bombay-76

SINGLE crystals of metals and semiconducting materials are of substantial value as they have found significant applications in solid state devices. To-date almost all naturally occurring crystals and a number of metal crystals have been grown in laboratories for investigation and a great deal of experimental data has been obtained on the growth of these crystals. During recent years, several reports dealing with developments in crystal growth from vapour phase have been published. CdS single crystals have been grown from the vapour phase by Frerichs method.[1] Optimum conditions for the growth of zinc and cadmium single crystals have been investigated in detail by Keepin[2] and Price.[3] Zelenskii and Petel'guzov[4] have grown magnesium single crystals by vacuum evaporation and condensation method. A feature of this particular method is that no seed is required for the growth. At times crystals with a base of 25 mm. were grown. In the present report, an apparatus is described for growing zinc monocrystals from the vapour phase. Conditions for satisfactory growth have been established.

EXPERIMENTAL PROCEDURE

A temperature gradient furnace was constructed for the experiments. The heating element (22 SWG, nichrome wire) was tightly wound on a 35 cm. long silica tube, spacing the turns to suitably achieve a temperature gradient and a short constant temperature zone close to it. The furnace was mounted in a vertical position for the experimentation. High-purity zinc block was sealed under vacuum in a pyrex capsule of about 4 to 5 cm. length and having one end tapered. This capsule was inserted in another slightly larger diameter pyrex tube. This unit was further inserted into the furnace such that the tapered end of the capsule was in the useful or growth zone of the furnace. The line diagram of the experimental set-up and the plot showing the thermal conditions inside the furnace are reproduced in Figs. 1 and 2 respectively.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1. USEFUL OR GROWTH ZONE
2. ZINC VAPOURS
3. RESULTING ZINC CRYSTALS
4. OUTER PYREX GLASS TUBE
5. SEALED PYREX CAPSULE
6. ZINC BLOCK SEALED UNDER VACUUM
7. GRAPHITE DISC
8. GLASS ROD SUPPORT FOR CAPSULE
9. SILICA TUBE
10. REFRACTORY LINING
11. CONSTANT TEMPERATURE ZONE

FIG. 1. Experimental set-up.

The useful or the growth zone and the constant temperature zone are clearly indicated in Fig. 2. The pyrex tube containing the capsule was pulled at a rate of 0·5 cm. or 1·0 cm./hr. by a motorgear train assembly for a distance of 4 cms. The furnace was gradually put off, capsule allowed to cool inside the furnace and taken out.

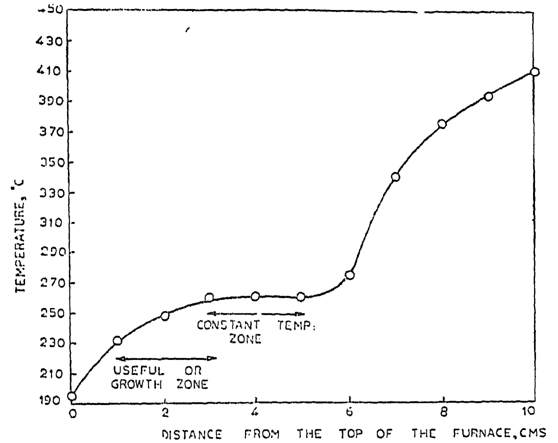

FIG. 2. Plot showing the thermal conditions inside the furnace.

TABLE I

Summary of the experimental results

Experiment No.	Experimental conditions	Materials inside the capsule	Time of pulling/keeping the capsule (hr.)	Results
1	Capsule pulled at 1 cm./hr. rate	Zinc block	4	Deposition
2	Capsule pulled at 0·5 cm./hr. rate	do.	7	Very small crystals
3	do.	Zinc block on graphite disc	8	Slightly bigger crystals
4	Capsule static	do.	24	Crystals of 2×2 to 2×10 mm. section obtained
5	do.	do.	28	Globular crystals of sizes from 8×6×5 to 2×2×5 mm. obtained

In another set of experiments the zinc block was cast under vacuum and kept on a thin graphite disc in a pyrex tube; the tube was then sealed under vacuum to get the capsule. This capsule was as before pulled through the furnace at a rate of 0·5 cm./hr. for a distance of 4 cms.

Appropriate conditions for satisfactory growth appeared to have been established, when the capsule containing the zinc block resting on the graphite disc was kept static at a fixed distance from the top of the furnace for about 24 hours. The temperature gradient in the growth zone close to the constant temperature zone was maintained at 15° C./cm. The length of the constant temperature zone was about 2·0 cms. and that of the useful or growth zone was about 1·5 cms.

RESULTS AND DISCUSSION

The effect of four variations in experimental conditions was studied on the growth of zinc crystals. Some crystallisation was observed on the walls of the capsule in the case where graphite disc was not used and the capsule was pulled at the rate of 1·0 cm./hr. Resulting crystals were too small to perform any test.

In the second variation where the graphite disc was not used and the capsule was kept static, denser crystallisation was noticed. In this case also size of the crystals was not large enough to perform any further tests. In the third variation the graphite disc was used and the capsule was pulled at the rate of 0·5 cm./hr. In this case higher temperature was necessary for melting zinc. The capsule on pulling yielded only dense crystallisation all over the walls. The size of the crystals in this case was again too small.

In the fourth and the most suitable variation the zinc block was kept on the graphite disc inside the capsule and the capsule was kept static. The tapered end of the capsule was well within the useful or growth zone and the zinc block on the graphite disc was in the constant temperature zone. Globular crystals of sizes ranging from 2 × 2 × 5 to 8 × 6 × 5 mm. were obtained in the growth zone. X-ray back reflection patterns were obtained to ascertain single crystallinity of the crystals. Presence of graphite disc inside the capsule appeared to be most suitable for maintaining the appropriate thermal conditions for single crystal growth. It is suggested that the same experimental set-up can be employed to grow single crystals of metals having low melting point and high vapour pressure. The experimental results in detail are presented in Table I.

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LETTERS TO THE EDITOR

DEPOLARISATION EFFECTS OF DETECTOR SIZES IN GAMMA-RAY POLARISATION MEASUREMENTS

The polarisation effects in incoherent scattering of gamma-rays are predicted by Klein-Nishina[1] law and a few attempts[2-4] were made to verify these predictions. The experimental set-up used in the recent investigation[4] was a two-channel sum-coincidence set-up in order to simultaneously record the data in two orthogonal planes with little interference from other types of unwanted radiation. In this set-up as well as in other experimental set-ups detectors of large sizes are usually employed to obtain good statistics of counting. It is therefore possible that considerable "smearing effects" are involved thereby causing depolarisation effects in the measured asymmetry ratios. An experimental investigation is carried out to study this effect.

In the present experimental set-up[4] a 10 curie ^{137}Cs source was employed and the asymmetry ratios were determined with three scintillation detectors [NaI(T-1) crystals] connected in two sum-coincidence arrangements. The central crystal was of dimensions 1″ dia. × 1″ high while the two side crystals were of dimensions 1½″ dia. × 1″ high. For different angles in the scattering and orthogonal planes, the effective angular spreads and track lengths vary. Consequently, the overall weightages for finite detector sizes have to be made taking the corresponding photopeak efficiencies. The photopeak efficiencies are therefore determined experimentally for the two side crystals using an experimental set-up similar to that of Frankel.[5] For this purpose a lead collimator of 2 mm. diameter is employed and the spectra of monochromatic gamma sources (energies 87, 192 and 280 keV) are recorded for different angular orientations of the detectors. The counts under the photopeaks normalised to the corresponding count for normal incidence yielded the relative photopeak efficiencies for different angular orientations. Using these photopeak efficiencies, the cross-sections are numerically integrated over the angular spreads involved in each case. The theoretical values thus obtained are corrected for finite size effects. These values (Theo. 1) together with uncorrected values (Theo. 2) and the experimental values are given in Table I.

Table I

Asymmetry ratios (N_0/N_ϕ)

(N_0 Count rate in the normal direction. N_ϕ Count rate at various scattering angles)

Azimuthal angle (°)		Asymmetric ratios		
		N_0/N_{30}	N_0/N_{60}	N_0/N_{90}
45	Theo. 1	1·09 ± 0·11	1·32 ± 0·13	1·48 ± 0·15
	Theo. 2	1·08 ± 0·05	1·30 ± 0·07	1·44 ± 0·07
	Expt.	0·99 ± 0·05	1·19 ± 0·06	1·32 ± 0·07
60	Theo. 1	1·14 ± 0·11	1·60 ± 0·16	2·00 ± 0·20
	Theo. 2	1·13 ± 0·05	1·55 ± 0·08	1·89 ± 0·10
	Expt.	1·03 ± 0·05	1·43 ± 0·07	1·76 ± 0·09
75	Theo. 1	1·18 ± 0·12	1·82 ± 0·18	2·49 ± 0·25
	Theo. 2	1·16 ± 0·06	1·74 ± 0·09	2·31 ± 0·12
	Expt.	1·05 ± 0·05	1·61 ± 0·08	2·22 ± 0·11
90	Theo. 1	1·16 ± 0·12	1·73 ± 0·17	2·28 ± 0·23
	Theo. 2	1·14 ± 0·06	1·61 ± 0·08	2·02 ± 0·10
	Expt.	1·05 ± 0·05	1·49 ± 0·08	1·91 ± 0·10

It can be seen from Table I that the errors in corrected theoretical values are greater than those in the uncorrected values. This is due to the fact that the corrected theoretical values include errors in the determination of the relative photopeak efficiencies. Taken together with errors, the values in Table I show that there is good agreement among the different values in all cases. These results indicate that the depolarisation effects of the detectors of sizes such as those used in the present study are negligible for the determination of asymmetry ratios.

Laboratories for Nuclear Research,
Andhra University,
Waltair, *May* 26, 1969.

A. Sanyasi Raju.
V. Lakshminarayana.

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BEHAVIOUR OF METAL AMALGAM ELECTRODES IN VOLTAMMETRY

THE metal amalgam wire electrodes are useful where the conventional electrodes fail,[1,2] but the mechanism of their electrode response is obscure. The potentiometric and differential cathode-ray polarographic work is presented here to assess the performance of silver, silver amalgam and zinc, zinc amalgam indicator electrodes. The experimental details are the same as reported earlier.[3,4]

Potentiometric Work.—Potential—pM curves were plotted for metal and amalgam electrodes and the slopes were compared. Silver and its amalgam electrode have slopes of 45 and 50 mV/pM for Ag^{+1}. For Fe^{+3}, Cu^{+2} and Cd^{+2} slopes of 67, 36 and 20 were obtained for amalgam electrode and no response for silver electrode. For these ions the amalgam electrode appears to behave as mercury electrode. The slopes for Zn^{+2}, Cd^{+2} and Hg^{+2} for zinc electrode are 30, 60 and 16 mV/pM, whereas for amalgam electrode they are 86, 5 and 10 mV/pM. Zinc amalgam electrode does not behave in the least as mercury electrode.

Polarographic Work.—Silver amalgam behaves as silver electrode in the case of blank curves which are due to the reduction of adsorbed oxygen on the electrode surface. The zinc amalgam electrode exhibits not very serious deviations from the zinc electrode for blank curves. This shows that the amalgam film forms on top of the oxide film. The peak potentials of metal and amalgam electrodes and the half-wave potentials of DME obtained for various cations are given in Table I. The comparison of peak potentials and half-wave potentials will reveal whether the amalgam electrode behaves as mercury electrode or metal electrode.

TABLE I

Comparison of metal and amalgam wire electrodes in polarography

No.	Amalgam electrodes		Metal electrodes				Remarks
	Ag (Hg) Ep, V	Zn (Hg) Ep, V	Ion	$E_{\frac{1}{2}}$, DME, V	Zn Ep, V	Ag Ep, V	
1	−0·15	−0·40, −1·26	Supporting electrolyte alone		−0·15, −0·73 −1·20	−0·15	Blank curves. For Ag and Ag (Hg) electrode supporting electrolyte – 0·1 M sulphosalicylic acid. For Zn and Zn(Hg) – 1 M acetate, buffer
2	+0·10	−0·00	Ag^{+}	0·00	0·98	0·60	
3	−0·28	−1·52	Hg^{++}	0·00	−1·42	−0·43	
4	−0·07, −0·19	−1·11	Cu^{++}	−0·07, −0·20	−1·15	No reduction	
5	−0·77	−0·60	Cd^{++}	−0·65	−0·60	do.	
6	No reduction	−1·23	Zn^{++}	−1·10	−1·29	do.	
7	−0·3	No reduction	Fe^{+++}	−0·15	No reduction	do.	
8	No reduction	−0·80	Tl^{+}	−0·47	−0·85	do.	
9	do.	No reduction	Ni^{++}	−1·10	No reduction	do.	
10	do.	do.	CrO_4^{--}	−0·80	do.	do.	

It is clear from the results that silver amalgam electrode behaves as mercury electrode for the reduction of Ag^{+1}, Cd^{+2}, Cu^{+2} and Fe^{+3}; for all the other ions it behaves as a silver electrode. Zinc amalgam electrode behaves as a mercury electrode for Cd^{+2}, Zn^{+2} and Ag^{+1} reduction, for other ion reductions it behaves as a zinc electrode.

Thus potentiometric and polarographic data show that the amalgam wire electrodes exhibit dual behaviour in its response. By having a film of amalgam on the metal electrode surface, it does not always behave as a mercury electrode. Only for some ions, notably Ag^{+1} and Cd^{+2}, it does behave as a mercury electrode indicating that these ions are reduced in the amalgam film. For rest of the ions, amalgam electrode behaves as the respective metal electrode, the ions diffusing through the amalgam film and reducing on the base metal. This dual behaviour is very useful in the analytical work as in the separation of mercury and silver peaks.

I thank Dr. V. T. Athavale, Head, Analytical Division, for his constant encouragement.

Analytical Division, R. G. DHANESHWAR.
Bhabha Atomic Res. Centre,
Modular Laboratories,
Trombay, Bombay-85, *April* 5, 1969.

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CATALYSED DECOMPOSITION OF FERROCYANIDE ION BY SULPHUR LIGATED 'CLASS *b*' METAL IONS

It is well known[1] that the hexacyanoferrate (II) and pentacyanoaquoferrate (II) ions are highly stable in aqueous solution. In acid medium[2] very slow decomposition of ferrocyanide solutions has been reported. We have observed that the decomposition of ferrocyanide solution, however, is strongly catalyzed by the presence of S-ligated 'class *b*' metal ions. The decomposition then occurred to the maximum extent in the pH range 2 to 5 when working with 10^{-3} to 10^{-5} molar concentrations of both ferrocyanide and the metal complexes. The S-ligands employed were thiourea (T), thioglycolic acid and various dithiocarbamates; the metal ions found most effective were Hg(II), Ag(I) and Cu(I). These metal ions in the absence of S-ligands affected decomposition of ferrocyanide solutions only to a limited extent. The final product of the decomposition carried out in air was confirmed to be Prussian blue (absorption maximum 690 mμ).

The decomposition apparently results by progressive removal of cyanide ions from the co-ordination site of Fe^{2+} ions, for example, by 'class *b*' metal-thiourea complexes, $[MT_x]^{+n}$, as follows:

$$[MT_x]^{+n} + [Fe(CN)_6]^{-4} \rightarrow [MT_x\,Fe\,(CN)_6]^{+n-4} \quad (1)$$

$$[MT_xFe(CN)_6]^{+n-4} + H_2O \rightarrow [MT_xCN]^{+n-1} + [Fe(CN)_5(OH_2)]^{-3} \quad (2)$$

$$[MT_xCN]^{+n-1} + H^+ \rightarrow [MT_x]^{+n} + HCN. \quad (3)$$

Initially, formation of a loose complex as in (1) is envisaged between the Fe(II)-cyanide complex (hexacyano to start with and later lower cyano complexes with progress of reaction) which changes over by cyanide transfer as in reaction (2), to a mixed thiourea-cyano complex of the 'class *b*' metal M, $[MT_xCN]^{+n-1}$. The complex $[MT_xCN]^{+n-1}$ will lose CN^- by reaction (3), regenerating $[MT_x]^{+n}$ which can effect further decyanation of Fe^{2+}. The ultimate Fe(II) species will be $[Fe(OH_2)_6]^{2+}$ which on aerial oxidation gives $[Fe(OH_2)_6]^{+3}$. This would react with undecomposed ferrocyanide to yield Prussian blue. In absence of S-ligands the metal ions M^{+n}, though they may initially displace part of cyanide ions from ferrocyanide, do not further act as catalysts, because these metal cyanide complexes are quite stable. Though no direct evidence was obtained in the present studies for complexes of type $[MT_xCN]^{+n-1}$ in solution phase, their formation is supported by the well-known existence of many mixed complexes of thiourea and halide and pseudohalide ions, with 'class *b*' metal ions such as HgT_2Cl_2, AgT_2Cl, CuTCl, CuT_3Cl; $HgT_2.(SCN)_2$, $AgT_3.SCN$, CuT.SCN, etc. Cyanide ion being a typical pseudohalide ion may be expected to behave similarly. It was possible in some cases to isolate solid complexes, containing ferrocyanide and S-ligated 'class *b*' metal groups. For example, when solutions of $HgT_3(NO_3)_2$ and potassium ferrocyanide were intermixed a sparingly soluble yellow complex of composition $[HgT_3]_2[Fe(CN)_6]$ was obtained. (Analyzed Hg 37·1%, Fe 5·38%, S 18·69% required for $[HgT_3]_2.[Fe(CN)_6]$ Hg 37·49%, Fe 5·22%, S 17·98%).

Even in the solid state on exposure to air, this complex changed to Prussian blue and other products on keeping for several days in darkness.

The 'class *a*' metal ions such as Co^{2+}, Ni^{2+}, Zn^{2+} and the border ones such as Cd^{2+} did not catalyze the decomposition of aqueous ferrocyanide solution in presence and absence of S-ligands. This is to be expected from the low stability known for the S-complexes of these ions.[3,4]

Dept. of Chemistry, M. Ramakrishna Udupa.
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Madras-36, *May* 2, 1969.

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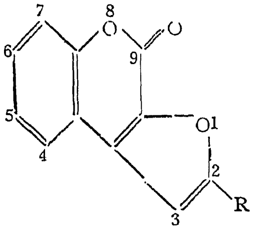
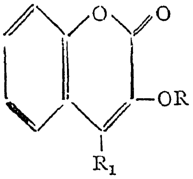
SYNTHESIS OF 2-METHYL-9H-FURO (2, 3-C) BENZOPYRAN-9-ONE, A FUROCOUMARIN DERIVED FROM 3-HYDROXYCOUMARIN

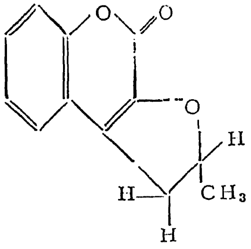
Dholakia and Trivedi[1] synthesised 4H-Furo (3, 2-C) benzopyran-4-one from 4-hydroxycoumarin. An attempt to prepare 9H-Furo (2, 3-C)-benzopyran-9-one(I *a*) by this procedure met with failure as 3-hydroxycoumarin failed to condense with malic acid or ethyl acetoacetate in the presence of concentrated sulphuric acid or anhydrous aluminium chloride. It was, therefore, thought of interest to build up furan ring on 3-hydroxycoumarin by a different route.

3-Hydroxycoumarin (II *a*), on allylation with allylbromide and potassium carbonate in refluxing acetone, gave 3-allyloxycoumarin (II *b*) m.p. 98° C., which underwent Claisen rearrangement to give 4-allyl-3-hydroxycoumarin (II *c*), m.p. 149° C., when refluxed with dimethyl aniline under nitrogen atmosphere. The ring closure of (II *c*) to (III), m.p. 111° C., was accomplished by trituration with concentrated sulphuric acid for 10 minutes at room temperature. This method was found superior to earlier methods[2] which used hydrobromic acid or pyridine hydrochloride. The compound (III) was dehydrogenated by refluxing it with diphenyl ether in the presence of palladised charcoal (10%) to 2-methyl-9H-Furo(2, 3-C)-benzopyran-9-one (I *b*), m.p. 159° C. All compounds described above gave satisfactory analytical results. Furocoumarins of this type having different substituents like Br, OCH_3, etc., in the benzenoid part of the furocoumarin ring have been synthesized by this procedure and will be published elsewhere.



I *a*: R=H
I *b*: $R=-CH_3$





(III)

II *a*: $R=H$; $R_1=H$
II *b*: $R=-CH_2-CH=CH_2$; $R_1=H$
II *c*: $R=H$; $R_1=-CH_2-CH=CH_2$

Thanks are due to Professor S. Sethna for his keen interest in this work and to Dr. S. S. Lele for micro-analyses of the compounds.

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Faculty of Science,
M.S. University of Baroda,
Baroda-2, *May* 15, 1969.

Y. A. Shaikh.
K. N. Trivedi.

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TITRIMETRIC DETERMINATION OF FERROCYANIDE

Ferrocyanide is mainly determined by oxidation or precipitation methods. Following the application of 4-(2-pyridylazo)-resorcinol (PAR) as complexometric[1] and spectrophotometric[3] reagent, and its application for complexometric determination[3] of Pb^{2+}, Pb^{2+}.PAR chelate was used as end-point detection in determination of several anions.[2,4] The present study has revealed the possibility of direct titration of $[Fe(CN)_6]^{4-}$ with Pb^{2+}, using Pb^{2+}-PAR chelate for end-point detection. Due to slight solubility of Pb_2 $[Fe(CN)_6]$, reddish colour developed from the start of titration, which made end-point detection rather difficult. Hence, isopropyl alcohol has been added to titrating mixture. Data obtained with isopropyl alcohol concentration maintaining from 10% to 40% gave fairly accurate and reproducible results.

Lead nitrate solution is standardised[5] as usual whereas standard solution of ferrocyanide is prepared from pure sample of potassium ferrocyanide (BDH AnalaR). ~ 0·02 M solution of PAR is prepared by dissolving 0·5 g. of its monosodium salt in 100 ml. of water.

Aliquots of ferrocyanide solution are taken in 250 ml. conical flask, appropriate volume of isopropyl alcohol added, ~ 0·2 g. of hexamine added, pH adjusted to 6·5–8·0 by dilute acetic acid, 1 or 2 drops of dyestuff added, and titrated with standard lead nitrate solution, with constant stirring of solution, until the colour change from yellow/orange-yellow to brilliant rose-red is permanent. The colour change is quite sharp in presence of hexamine. The reaction between Pb^{2+} and ferrocyanide is found to be stoichiometric, with the formation of Pb_2 $[Fe(CN)_6]$ in the ratio of 2 : 1.

$$2\,Pb^{2+} + [Fe(CN)_6]^{4-} \rightarrow Pb_2\,[Fe(CN)_6].$$

Results are returned in Table I.

Table I

Vol. of alcohol + water ml.	Amount of ferrocyanide			
	Taken mg.	Found mg.	Diff. mg.	Error %
5 + 9	2·645	2·614	0·031	−1·20
10 + 15	5·290	5·325	0·035	+0·60
5 + 25	10·59	10·56	0·03	−0·30
10 + 20	21·19	20·91	0·28	−1·30
20 + 60	42·38	41·62	0·76	−1·70
20 + 48	52·97	53·51	0·54	+1·08

Interfering cations, *e.g.*, Cu (II), Hg (I, II), Sb (III), Fe(III), Ni(II), Zn(II), Th(IV), U(VI), Mn(II), Al(III) and Tl, etc., are to be removed (by ion-exchange) and various anions which form precipitate with Pb^{2+}, *e.g.*, SO_4^{2-}, PO_4^{3-}, MoO_4^{2-}, WO_4^{2-}, AsO_4^{2-}, SeO_3^{2-}, TeO_3^{2-}, Halides, $C_2O_4^{2-}$ IO_3^{1-}, BrO_3^{1-}, etc.

Dept. of Chemistry,
Indian Institute of Technology,
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M. C. Eshwar.
S. G. Nagarkar.

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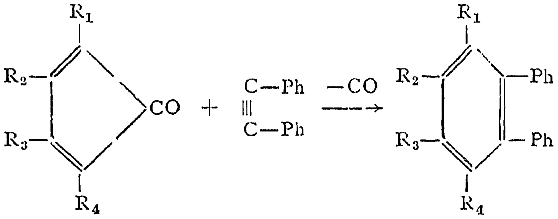
SYNTHESIS OF POLYPHENYLATED BENZENE DERIVATIVES

Only a few highly phenylated benzene derivatives are known,[1-4] and we have prepared a large number of polyphenylated benzene derivatives by dienesynthesis. Diphenyl acetylene was found to be a good dienophile only at high temperature[1,5,6] and condensed with cyclopentadienone derivatives smoothly when benzophenone was used as a solvent for condensation. After completion of the reaction a few drops of diphenyl ether were added to prevent the solvent from solidifying. The yields varied from 60 to 80%. The following compounds have been prepared:



I. $R_1=R_4=Me$; $R_2=R_3=Ph$ m.p. 352°
II. $R_1=R_4=Et$; $R_2=R_3=Ph$,, 324°
III. $R_1=R_4=n\text{-}Pr$; $R_2=R_3=Ph$,, 264°
IV. $R_1=R_3=R_4=Ph$; $R_2=p\text{-}Me\text{-}C_6H_4$,, 353°
V. $R_1=R_3=R_4=Ph$; $R_2=p\text{-}Et\text{-}C_6H_4$,, 343°
VI. $R_1=R_3=R_4=Ph$; $R_2=p\text{-}Ph\text{-}C_6H_4$,, 292°
VII. $R_1=Me$; $R_2=R_3=R_4=Ph$,, 286°[3]
VIII. $R_1=Et$; $R_2=R_3=R_4=Ph$,, 314°
IX. $R_1=n\text{-}Pr$; $R_2=R_3=R_4=Ph$,, 345°
X. $R_1=R_3=R_4=Ph$; $R_2=p\text{-}MeO\text{-}C_6H_4$,, 324°
XI. $R_1=R_3=R_4=Ph$; $R_2=p\text{-}EtO\text{-}C_6H_4$,, 310°
XII. $R_1=R_4=Ph$; $R_2=R_3=p\text{-}Me\text{-}C_6H_4$,, 354°

The compounds sublime easily and were crystallized from benzene. Melting points were determined by heating in a metal block and were not corrected.

Org. Chem. Lab.,
Univ. of Burdwan,
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A. J. Bhattacharyya.
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SALT EFFECTS ON THE HALF-ESTER HYDROLYSIS IN AQUEOUS DMSO

In our recent publication,[1] the results of the alkaline hydrolysis of diethyl succinate and diethyl phthalate in aqueous DMSO were reported. These were explained on the basis of an increased transition state solvation in mixtures containing larger proportions of DMSO and by a diminution in hydroxide ion solvation as a result of competition between this anion and the large amounts of DMSO molecules for water molecules. A point of interest in this investigation is the nature of the second step of the hydrolysis reaction—whether this should be regarded an ion-ion reaction or an ion-dipole reaction. While Svirbely and Kutcha hold the view that this is essentially an ion-ion reaction,[2] it has also been argued that half-ester hydrolysis requires the same ion-dipole mechanism as the mono-carboxylic esters or as the first stage of diester hydrolysis.[3,4] The investigations of both these groups of workers have been confined to dioxan-water media as the solvent system. In view of the fact that aqueous DMSO provides a system with peculiar properties, we present in this communication our results on the salt effects on the alkaline hydrolysis of dibasic esters in this solvent system.

The effect of added KCl over a ten-fold concentration range ($\mu = 0 \cdot 02\text{–}0 \cdot 2$ M) on the alkaline hydrolysis of dicyclohexyl phthalate has been studied in 80% DMSO–20% H_2O at 45° C. The kinetics was followed by estimating the variation of hydroxide ion concentration with time using a screened indicator composed of neutral red and methylene blue. The individual rate constants k_I and k_{II} were evaluated by the Frost-Schwemer treatment.[5] The results are presented in Table I.

TABLE I

Salt effects in diester hydrolysis in aqueous DMSO

Compound : Dicyclohexyl phthalate.
Solvent : 80% DMSO.
[Ester] = 0·005002 M. [NaOH] = 0·01004 M.
Temperature : 40° C.

Ionic strength	$k_I \times 10^2$ litre-mole^{-1} sec.$^{-1}$	$k_{II} \times 10^3$ litre-mole^{-1} sec.$^{-1}$	k_I/k_{II}
0·02	5·25	6·28	8·37
0·06	5·27	6·72	7·85
0·08	5·39	7·06	7·63
0·10	5·77	7·93	7·27
0·12	5·85	8· 6	6·68
0·20	5·74	9·17	6·26

It is observed that on addition of increasing quantities of the inert electrolyte—potassium chloride, the k_I/k_{II} ratio decreases progressively. Further, the first step is not susceptible to any salt effect and it is only the rate constant for the second step that increases with increasing ionic strength pointing to a positive primary salt effect on this step only. There indeed exists a linear relationship between $\log_{10} k_{II}$ and $\sqrt{\mu}$—an observation which is in accordance with the theory for a reaction between ions of like charge. We have also checked this up independently by studying the effect of added salt on the alkaline hydrolysis of sodium monobenzyl phthalate (Table II).

TABLE II

Hydrolysis of sodium monobenzyl phthalate

[Ester] = 0·01016 M. Solvent : 80% DMSO.
[NaOH] = 0·01016 M. Temperature : 30° C.

KCl (M)	$k_{II} \times 10^2$ litre-mole^{-1} sec.$^{-1}$
0·04	3·05
0·085	3·79
0·15	4·12

A similar increase in the second order rate constants with increasing concentration of added electrolyte is observed here too. However, it is to be pointed out that the maximum rate increase in both the cases studied is only about 50%, while typical ion-ion reactions experience more profound salt effects. This is most probable because the reaction for which the rate constant is measured is essentially an ion-dipole reaction, although the half-ester anion has a charged centre which would influence the reaction rate. For example, Broach and Amis found that the reaction of ethyl bromo-malonate with thiosulphate ion obeyed the salt effect as well as dielectric constant requirements for an ion-dipole reaction rather than an ion-ion reaction.[6] Further, the rate increase observed in the present solvent system 80% DMSO–20 % H_2O is about the same as was obtained by previous workers in dioxan-water mixtures of similar dielectric constant.[2] This is in keeping with the recent findings of Fuchs and his associates that the solvation enthalpies of ions (for example, lithium chloride) in DMSO is the same as in water.[7]

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Vivekananda N. VENKATASUBRAMANIAN.
College,
Mylapore, Madras-4, *May* 16, 1969.

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^{18}O ANALYSIS OF TAP-WATER

IN the past thirty years, a large number of workers have studied the variation of ^{18}O and ^2D content in natural waters. The sea-water has got an almost constant isotopic composition whereas freshwater samples show a large variation. The isotopic composition of freshwater depends on various factors such as climate, altitude, latitude and distance from the sea. Both ^2D and ^{18}O contents are depleted in rains falling in winter than in summer. A knowledge of the isotopic composition of water can be used for distinguishing waters of various origin. In this communication we have reported the ^{18}O constitution of tap-water.

Tap-water samples were analyzed in different seasons. The source of the tap-water is the tube-well at I.I.T., Kanpur. The ^{18}O content of water was measured using the CO_2 equilibrium method given by Epstein and Mayeda (1953). The isotopic ratios of the CO_2 was determined before and after equilibration, using a 6″–60°-RMS-19 ratio mass spectrometer. The ratios are reported in the δ terminology defined as :

$$\delta‰ = \left(\frac{^{18}O/^{16}O \text{ sample}}{^{18}O/^{16}O \text{ standard}} - 1\right) \times 1000.$$

The δ ^{18}O of H_2O are calculated using the known equilibrium constant for the isotope exchange reaction (Urey, 1935).

$$H_2{}^{18}O + \tfrac{1}{2} C^{16}O_2 \rightleftharpoons H_2{}^{16}O + \tfrac{1}{2} C^{18}O_2.$$

The δCO_2 values were corrected for valve mixing and ^{13}C variations according to the equations given by Craig (1957). The δ ^{18}O values of water are reported relative to SMOW (standard mean ocean water).

The isotopic values of the tap-water are shown in Table I. The reported values are the average of two or more analyses, with a precision of ± 0·2‰. The variation of the ^{18}O content of the three sets of samples are due to the variation in the ^{18}O content of ground water. The variation of the ^{18}O content of ground water can be explained on the basis of the extent of evaporation and the mixing of rain-water.

TABLE I

^{18}O *Tap-water*

Sample No.	$^{18}O_{SMOW}$	Period of collection
1	−7·66	August
	−7·69	..
	−7·04	..
2	−5·12	December-January
	−5·38	..
3	−4·58	May-June
	−4·07	..

$H_2{}^{16}O$ has a lower heat of vaporization than $H_2{}^{18}O$ and so evaporation causes the increase in ^{18}O content of ground water (Craig and Boato, 1955). The rain-water for similar reasons is lighter in ^{18}O content and its mixing with ground water causes depletion in ^{18}O of ground water. Thus in rainy season the ground water is depleted in ^{18}O due to mixing of rain-water, while in summer the evaporation is the significant factor and causes the increase in its ^{18}O content. The ^{18}O content in winter is of intermediate value. This is evidenced by the samples studied which show the expected trend.

Dept. of Chemistry, N. V. PILLAI.
Indian Inst. of Technology, T. SHARMA.
Kanpur (U.P.), India, *May* 27, 1969.

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LAMINARAN FROM INDIAN BROWN SEAWEEDS

LAMINARAN, a water-soluble polymer of D-glucose finds use as a soluble surgical dusting powder and as a soluble base for antibiotic dusting powders.[1] It is used as a source of glucose. A promising use of laminaran is as a possible blood plasma substitute. It can be used as a starting material for 2-deoxy-D-ribose. Sodium laminaran sulphate is tested as a possible blood anticoagulant.

Laminaran is found in many of the brown algæ where it serves as a reserve carbohydrate. It is found in greatest amount in the fronds of Laminaria,[2] a large family of brown seaweeds native to the seacoasts of western Europe, United States and Japan. Kelp also contains besides algin large amounts of laminaran. While algin occurs in almost all the brown algæ, the presence of laminaran is reported, besides Laminaracea, in *Fucus serratus* a brown alga of Fucacea family to which belong *Sargassum* spp. The vast resources of brown algæ on the Indian coast prompted us to determine the laminaran content of the brown seaweeds, and the results of our preliminary investigations are presented in this note.

Dried and milled algæ were extracted with 0·1 N hydrochloric acid for 6 hr. under stirring and the acid extract after neutralisation with alkali was evaporated to a small volume and coagulated with 85% alcohol. This fraction was dissolved in hot water and the clear solution (after filtration) was passed over Zeo-karb 225 column. The acid solution from the column was then treated with 85% alcohol to precipitate out the laminaran. The precipitate was washed with alcohol, dried at 60° C. and then weighed. The results expressed as percentage on the air-dried seaweed are presented in Table I.

The results show that although the alcohol coagulated fraction from the Indian brown seaweeds is fairly high ranging from 5 to 15%, the laminaran content of that is very small. The bulk of the fraction constituted fucoidin which was confirmed by its analysis for ash and sulphate. The data on the laminaran content, although not encouraging from the point of view of its economics, yet show that its recovery will be worthwhile as a by-product of algin industry.

TABLE I

Laminaran content of some of the Indian brown seaweeds

Sl. No.	Species		Habitat	Date of collection	Total alcohol coagulated fraction per cent on air-dried seaweed	Laminaran content per cent on air-dried seaweed
1	*Cystoseira indica*	..	Okha	16-12-1967	6·8	0·06
2	*Sargassum swartzii*	..	,,	,,	6·9	0·54
3	*Sargassum Johnstonii*	..	,,	17-12-1967	8·6	0·45
4	*Sargassum wightii*	..	Mandapam	25-11-1968	5·4	traces
5	*Sargassum tenerrimum*	..	,,	,,	4·8	,,
6	*Sargassum tenerrimum*	..	Okha	17-12-1967	15·9	,,
7	*Sargassum* sp.	..	Pamban	17-11-1965	13·0	0·58
8	Drift seaweed	..	,,	,,	14·7	0·64
9	*Turbinaria* sp.	..	,,	,,	11·4	0·63
10	*Sargassum cinereum*	..	Sikka	10—6-1967	9·9	0·50
11	*Laminaria angustata*	..	Hokhaido, Japan	15—9-1964	19·83	2·80
12	*Ascophyllum nodosum*	..	Oakney Island	1962	23·3	1·12

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Central Salt and Marine Chemicals Res. Inst., Bhavnagar, *April* 14, 1969.

H. N. SHAH.
A. V. RAO.

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OCCURRENCE OF DIOSGENIN IN *ASPARAGUS RACEMOSUS* LEAVES

IN continuation of our earlier report[1] on the chemical components of *Asparagus racemosus* and in view of the recent record[2] on the isolation of diosgenin from *Asparagus sprengeri*, we wish to record the results of our systematic chemical work on *Asparagus racemosus* leaves; Diosgenin has been isolated and the second flavonoid glycoside besides rutin recorded earlier[1]. has been identified as quercetin-3-glucuronide.

Fresh leaves of *A. racemosus* were extracted with hot alcohol (90%) three times, and the total extract concentrated *in vacuo* after addition of some water towards last stages of concentration (frothing observed). The aqueous alcoholic concentrate was successively extracted with petroleum ether, ether and ethyl acetate. No crystalline solid was obtained from the petrol and ether fractions, while the ethyl acetate concentrate in methanol on keeping in an ice-chest for two days deposited an almost colourless solid, which, after recrystallisation from methanol, came out as colourless needles, m.p. 204–05°, $[\alpha]^{30}_{D}$ $-126°$ (chf.). It gave strongly positive steroid colour reactions. On acetylation (Ac_2O + anhyd. sod. acetate) yielded a crystalline acetate, m.p. 195–96° and when treated with benzoyl chloride in pyridine gave needles, m.p. 236–38°, $[\alpha]^{30}_{D}$ $-42°$ (pyridine). From these data and TLC in different solvent systems, the compound was identified to be diosgenin.[3]

The ethyl acetate mother liquor after the separation of diosgenin was studied for the fast-moving flavonol glycoside by preparatory paper chromatography, and it was identified as quercetin-3-glucuronide by its R_f values and comparison with the pigment from *Nelumbium speciosum*.[4]

The occurrence of diosgenin in *A. racemosus* is interesting from the point of chemotaxonomy of the genus *Asparagus*. Out of ten *Asparagus* species examined by Held *et al.*[2] only two, *A. sprengeri* and *A. officinalis*, contained diosgenin and the other eight did not biosynthesise any diosgenin.

Dept. of Chemistry, J.I.P.M.E.R., Pondicherry-6, *June* 3, 1969.

S. SANKARA SUBRAMANIAN.
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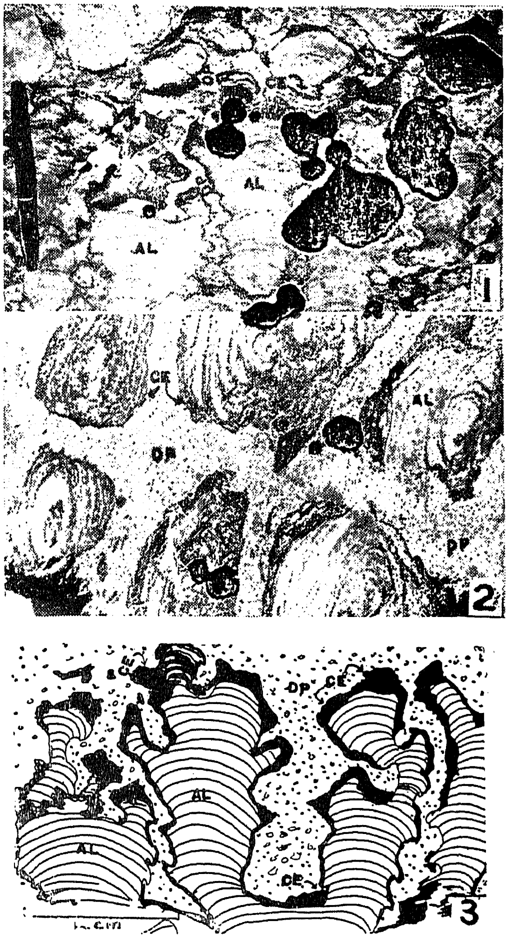
A NEW PHOSPHATIC HORIZON IN THE LATE PRECAMBRIAN CALC ZONE OF PITHORAGARH, KUMAUN HIMALAYA

A NEW horizon of mineral phosphate has been discovered in the Gangolihat Dolomites of the Late Precambrian Calc Zone of Pithoragarh in the Kumaun Himalaya. The Gangolihat formation includes a chain of lentiform bioherms of algal stromatolites. The stromatolite-bearing dolomitic limestones in the subdivision of Pithoragarh have been found moderately phosphatic. What was described as black chert enveloping and permeating these stromatolites (Misra and Valdiya;[1] Valdiya[2-4]) has turned out to be collophane. Preliminary analysis of six random chip samples shows that the average P_2O_5 content is about 12·9%.

Mode of Occurrence.—The stromatolites are partially or completely enveloped and locally permeated along the interlaminal partings by black opaque collophane. The tops and the saddles of the branched columns display relatively thicker encrustation of the phosphate mineral (CE in Figs. 1-3). The collophane has marginally replaced the periphery and the laminæ of the stromatolites. This is borne out by the myriads of tiny inclusions of carbonate, aphanitic carbonate-pellets and grains of quartz in the collophane base—all of which preserve the original preferred orientation of the constituents of the biolithite. The marginal parts of both the encrustations and pellets of collophane are commonly very diffuse and characterized by a progressively increasing amount of carbonate inclusions towards the host. The collophane is also seen emplaced transverse to the stromatolite laminæ, representing possibly the transverse fractures. The encrustation of a sample from Bisabajer yielded 17·67% P_2O_5.

The stromatolites are embedded in a mass of detrital, sand-sized pelletal limestone (pelsparite : DP in the figures). This detrital carbonate is characterized by disseminated pellets, stringers and clots of collophane. The average P_2O_5 content of four random chip samples from four different localities is 7·15%. The algal laminæ (AL in the figures), however, contain negligible quantity of phosphate.

The associated magnesite also contains veins, patches and stringers of black collophane especially where it shows replacement evidences.



FIGS. 1-3. Fig. 1. Cross-section of *Collenia baicalica* showing black encrustation of collophane. Locality: Bisabajer. Fig. 2. Transverse section of the above form. Locality: Forest Range Office, Chandaak. Fig. 3. Sketch of Fig. 1. Al—algal laminæ; DP—detrital sand-sized pelletal limestones with collophane pellets; CE encrustation of collophane.

Stratigraphic Setting.—In the field-succession the horizon of lentiform biohermal stromatolitic limestones occupies the lower part of the Gangolihat Dolomites Formation of the Calc Zone of Pithoragarh (Valdiya[2]). The partial succession of rocks is as follows:

	Berinag Quartzites
Gangolihat Dolomites	Purple phyllites interbedded with microcrystalline sandy limestone.
	Massive cherty dolomites with subordinate slates and calc-phyllites.
	Stromatolite-limestones and lentiform magnesite deposits.
	Sor Slates

Since the sequence is reversed, the rocks now at the top of the succession are actually older and those at the bottom younger. The commonest form of the stromatolites is *Collenia baicalica* (= *Baicalia baicalica*), which correlates the Gangolihats with the Middle Ripheans (1260 – 1000 m.y.) of the U.S.S.R. (Valdiya[4]).

Control of collophane localization.—The stromatolite-limestones are almost invariably associated with lentiform deposits of coarsely crystalline magnesite. Valdiya[3] has stressed the vital role of algæ in the development of favourable conditions for the formation of these magnesite deposits. The intimate association of the stromatolites with the phosphate mineral indicates that the algæ were also responsible for the localization of collophane. The black colour of this mineral is probably due to the pigment resulting from the decomposition of algal-derived organic matter.

Extent.—The phosphatic horizon is traceable for about fifteen kilometres from near Deopala in the Ramganga valley, through Baste, Dungra, Chandaak Forest Office, Targaon and Marh to Bisabajer in the subdivision of Pithoragarh. It is also seen in the Dungri-Dundu area, east of Kanalichhina and along the Rinn-Dewalthal belt.

The stromatolite-bearing horizon of the Calc Zone has a great lateral extent and stretches 130 km. north-west from the Kali valley to the Alaknanda valley and beyond in the Chamoli District of Garhwal. It has been repeated several times by folding between the North Almora-Saryu Thrust in the South and the Main Central Thrust of the Greater Himalaya. To what extent this horizon has been phosphatized, and to what degree, only a detailed investigation and prospecting will reveal.

The writer is grateful to N. H. Hashmi and D. N. Tewari of the Department of Chemistry, Lucknow University, for the chemical analysis of samples. Financial assistance from the Council of Scientific and Industrial Research is thankfully acknowledged.

Department of Geology, K. S. Valdiya.
Lucknow University,
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EFFECTS OF ENOVID ON THE LIVER, UTERUS AND ADRENAL OF THE RAT SUBJECTED TO A DIETARY RESTRICTION

The estrogen in the contraceptives is considered to be the major cause for the impaired glucose tolerance in many women.[1] It is well known that the liver exerts a major control over circulatory estorgens and nutritional modifications aggravate the capacity of the liver to inactivate the steroids.[2] Since there is existence of an interrelationship between nutrition, endocrine and other organs, the effects of enovid on the liver, uterus and adrenal were investigated under a dietary restriction.

Materials and Methods

Adult female rats of the Holtzman strain weighing 175–210 gm. were used in these investigations. The rats were divided into 4 groups of 6 animals each and were kept under experimental conditions for 30 days. Group I served as *ad libitum* fed controls. *Enovid at a dose of 0·02 mg. (0·0197 mg. 17 α-ethynyl-17-hydroxy-5-estrene-3-one *plus* 0·0003 mg. 17 α-ethynyl estradiol-3-methyl ether dissolved in olive oil) per 100 gm. of body weight was injected subcutaneously daily to group II. Group III received only one half of the amount of food ate by group I. Group IV was given a combined treatment, *viz.*, half food and enovid similar to those of the other groups. Cholesterol concentrations of adrenals and serum, and glycogen concentrations of liver and uterus were estimated according to the methods of Sperry and Webb[3] and Shifter *et al.*[4] respectively.

Results and Discussions

The present investigation showed that enovid reduced liver glycogen and increased liver weight (Table I *a*). A marked reduction in liver glycogen was also seen by dietary restriction alone. Similar dietary restriction *plus* enovid, however, showed some improvement in liver glycogen, but still it was much lower than those of *ad libitum* fed and enovid-treated rats. This could be due to decreased utilization of carbohydrate caused by estrogen-induced secretion of adrenocorticotrophin (ACTH).[6] Malnutrition is reported to affect the steroid detoxifying system of the liver adversely.[2] The depletion of liver glycogen reported here may be due to the reduced capacity of the liver to store glycogen either induced by malnutrition or by repeated treat-

TABLE I

Effects of enovid on glycogen and cholesterol under dietary restriction

(*a*) Effect on glycogen

Group	Liver				Uterus		
	Weight		Glycogen		Weight		Glycogen
	Actual gm.	gm./100 gm. body weight (B.W.)	mg./100 mg. fresh tissue	Total mg./liver	Actual mg.	mg./100 gm. (B.W.)	mg./100 mg. fresh tissue
I. *Ad libitum* fed control	6·7	3·6	1·05	72·1	356·1	191·7	0·042
	±0·027	±0·01	±0·219	±12·5	± 47·4	± 27·9	±0·005
II. *Ad libitum* fed + enovid	8·7	4·9	0·437	41·5	322·8	186·0	0·045
	±0·273	±0·149	±0·093	± 9·7	± 21·9	± 12·3	±0·005
III. Half-fed ..	4·5	3·7	0·061	2·68	120·8	100·8	0·077
	±0·176	±0·016	±0·016	±0·285	± 5·3	± 4·02	±0·011
IV. Half-fed + enovid	4·3	4·0	0·107	4·7	338·4	310·5	0·048
	±0·258	±0·007	±0·006	±0·408	± 33·3	± 14·1	±0·007

(*b*) Effect on cholesterol

Group	Adrenal				Serum	
	Weight		Cholesterol		Cholesterol	
	Actual mg.	mg./100 gm. (B.W.)	Total mg./100 mg. fresh tissue	Free mg./100 mg. fresh tissue	Total mg./100 ml. serum	Free mg./100 ml. serum
I. *Ad libitum* fed control	49·0	22·4	4·75	0·381	41·9	9·7
	± 1·22	± 0·507	±0·255	±0·042	± 3·31	±2·62
II. *Ad libitum* fed + enovid	56·0	30·1	3·19	0·419	16·9	2·3
	± 2·28	± 1·31	±0·332	±0·037	± 3·41	±0·522
III. Half-fed ..	36·8	30·5	2·76	0·247	36·0	9·4
	± 1·52	± 1·40	±0·140	±0·015	± 0·303	±0·701
IV. Half-fed + enovid	40·6	37·46	2·97	0·205	27·5	5·9
	± 1·86	± 1·43	±0·213	±0·019	± 2·96	±0·510

Six rats were taken in each group.

ment with enovid or both. On the other hand, enovid maintained uterine weight and glycogen at levels comparable to those of controls, but dietary restriction alone caused an increase in uterine glycogen (Table I *a*). These data probably indicate that during continuous stimulation with estrogen in enovid, the uterine weight and glycogen concentration stabilize. On the contrary, Mohla and Prasad[5] found that a single injection of estrogen increased liver and uterine glycogen in rats treated with progesterone. The increase in uterine glycogen following dietary restriction alone cannot be interpreted at present.

The results of the present study also showed that enovid reduced adrenal and serum cholesterol while adrenal weight was increased (Table I *b*). It is well known that ACTH stimulates utilization of adrenal cholesterol for steroidogenesis. A direct effect of ACTH on the accumulation of adrenal cholesterol was also demonstrated by Dexter *et al.*[7] They suggested that ACTH either stimulates an increase in uptake of cholesterol from the plasma or increases cholesterol synthesis by the adrenal or both. It seems logical, therefore, to suggest that repeated treatment with enovid causes continuous release of ACTH resulting in enhanced utilization of adrenal cholesterol at a rate faster than its accumulation. On the other hand, Leathem[2] suggested that malnutrition not only reduces hypophysial ACTH, but also prevents adrenal response to ACTH. Hence, the increase in serum cholesterol and decrease in adrenal cholesterol following dietary restriction alone or along with enovid treatment (Table I *b*) could be due to the reduced capacity of the adrenal to respond to ACTH with respect to the uptake as well as utilization of cholesterol.

The author wishes to thank Professor B. R. Seshachar, Head of the Zoology Department,

University of Delhi, for facilities. He would also like to thank Prof. M. R. N. Prasad of the Zoology Department for encouragement and help.

Department of Zoology, P. K. Paul.
University of Delhi,
Delhi-1, *May* 17, 1969.

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* Messrs. G. D. Searle Co., Chicago, U.S.A.

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A FISH THAT MOULTS ITS SKIN. *ACANTHOSPHEX LEURYNNIS* (JORDAN AND SEALE) FAMILY: BATHYAPLOACTIDAE

Recently I collected from the inshore waters of Porto Novo about 125 specimens of an interesting fish *Acanthosphex leurynnis* (Jordan and Seale).[1] This fish was originally described by Jordan and Seale as *Prosopodasys leurynnis* from two specimens collected in 1882–83 at Hong Kong. In 1938, Fowler[2] erected a new genus *Acanthosphex* to accommodate this species. Two of the specimens collected by me were kept alive in the laboratory aquarium for over three weeks. Each of the specimens moulted its skin six times during this period at intervals of about four days, and curiously enough, the moulting occurred at about 10 a.m. every time.

The skin of the animal came off in large pieces, but in some portions like the pectoral fin, the skin sloughed off as one entire piece like a glove. The moulted skin was examined and found to contain solid concretions. Sections of the skin were made and they revealed remarkable features. As will be seen from the photograph (Fig. 1) the cells above the pigment layer in the dermis contain large concretions which have no parallel in the skin of any other fish studied so far. The concretions were not soluble either in KOH or HCl. Smith[3] makes a casual mention of *Congiopodus spinifer* (Smith, 1961, p. 376. Fam.: Congiopodidæ) as the only fish known to moult, but no further reference has been available. There is no doubt, however, that the present specimen, *Acanthosphex*, shows remarkable features in its integument.

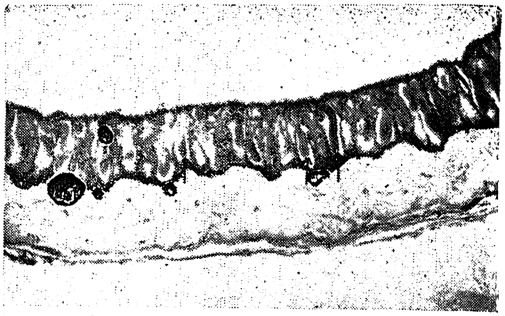

FIG. 1. Section of the skin of *Acanthosphex leurynnis*. Arrows show the concretions in the cells above the pigment layer in the dermis.

My thanks are due to Prof. R. V. Seshaiya, Director, for help and guidance.

Centre of Advanced V. Ramaiyan.
Study in Marine Biology
(Marine Biological Station),
Porto Novo, S. India, *May* 1, 1969.

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INHERITANCE OF MULTIHUSKED CONDITION IN RICE

Morphological variation in husk or hull has been reported by several investigators and includes triangular hull, depressed palea, palealess, long glumes, extra long glumes, asymmetrical glumes, claw-shaped hull, etc. Yet another variation is the multihusked condition. Here, in addition to the normal complement of glumes, *i.e.*, sterile glumes and fertile glumes (lemma and palea), the spikelets have a large number of glumes, varying from 1 to 9. Of the supernumerary glumes, 3 or 4 are usually well developed, while the rest are present as thin papery structures. Multihusked condition of the spikelet was noted in a variety Acc. 1441 (GH 10946) received through Dr. T. T. Chang of the International Rice Research Institute, Manila. The inheritance of multihusked condition was studied in a cross between this variety and another *indica* marker IM. 159, evolved at this Institute. Characters of the parents, their expression in F_1 and nature of segregation in F_2 are given in Table I. Panicles of the parents showing the contrasting

TABLE I

Character expression in parents and F_1 and nature of segregation in F_2

Character under study	Acc. 1441 G.H. 10946	F_1	IM. 159	Observation in F_2	P value for 3 : 1 ratio
Nature of husk ..	Multihusked	Normal	Normal	556 Normal 168 Multihusked	·3–·2
Nature of sterile glumes	Normal	,,	Long	554 Normal 170 Long	·5–·3
Hairiness of husk ..	Hairy	Hairy	Glabrous	368* Hairy 153 Glabrous	·05–·02

* Observation recorded in two out of the three families.

characters and panicles of some of the segregants from the F_2 generation are shown in Fig. 1. The enlarged spikelets are shown in Fig. 2.

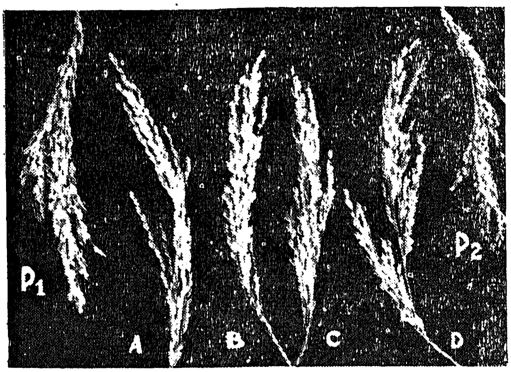

FIG. 1. Panicles of parents and typical segregants in F_2. P_1—Acc. 1441; P_2—IM 159; A—Normal spikelet with normal glumes; B—Normal spikelet with long glumes; C—Multihusked spikelet with normal glumes; D—Multihusked spikelet with long glumes.

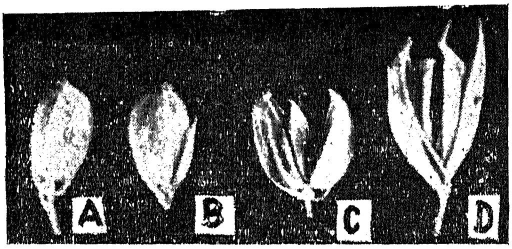

FIG. 2. Spikelets of A, B, C, D from Fig. 1 enlarged.

Monogenic inheritance of long empty glumes and glabrous husk had been reported by earlier workers (Ramiah and Rao[3] and Nagai[2]). The multihusked condition reported here is apparently controlled by a single pair of recessive genes. In a teratological variation (Polyhusked spikelets) reported by Butany and Nair[1] in one panicle, none of the polyhusked spikelets bore any seed. The number of extra husks varied from one five. The inheritance of this character was not reported by them.

The plants with long glumes, glabrous husk and multihusked spikelets bred true in F_3. Of the 14 families from F_2 plants with normal spikelets 5 bred true for normal spikelets and 9 showed segregation (3 normal; 1 multihusked; P value 0·9–0·8). Ten families from F_2 plants with hairy glumes and 6 families from F_2 plants with normal glume size were studied in F_3. In the first case 2 bred true for hairy glumes and eight showed segregation (P = ·5–·3); in the second case 3 bred true for normal glume size and three showed segregation (3 normal; 1 long; P = ·5–·3). The ratios obtained for the different characters were thus confirmed.

Both parents included in the study belong to *indica* subspecies. The gene controlling multihusked condition in rice is now designated as "*mh*". In the joint segregation '*mh*' segregated independently of the gene '*gl*' controlling glabrous husk and the gene '*g*' controlling long empty glumes. '*mh*' and "*g*" do not belong to a multiple allelic system.

Variation in the degree of expression of multihusked spikelets was noticed. A poor grain development was also observed in spikelets with large supernumerary glumes. Further, spikelet sterility was more in panicles with a high percentage of multihusked spikelets.

The authors are grateful to Dr. S. Y. Padmanabhan, Director, for his suggestions. They are also thankful to Dr. T. T. Chang, Geneticist, International Rice Research Institute, Manila, for supplying the material.

Central Rice Res. Institute, Cuttack-6 (Orissa), May 3, 1969.
R. SEETHARAMAN.
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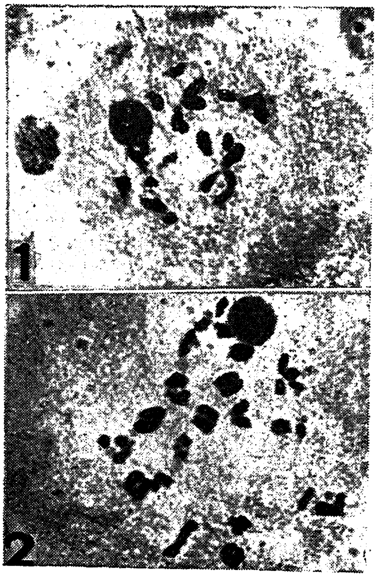
AMPHIDIPLOIDIZATION INDUCED BY DECAPITATION IN AN INTERSPECIFIC HYBRID OF *PENNISETUM*

SEVERAL methods of inducing ployploidy in plants are now known, some of the earlier techniques being by decapitation,[4,7] heat shock method,[5] centrifuging,[3] hormonal treatment of cut surfaces,[2] etc. Most of these methods did not give consistent results. Ever since the discovery of colchicine[1] it has provided an extremely efficient tool for inducing autopolyploidy in plants and for amphidiploidizing raw interspecific hybrids. However, reports of polyploidization by decapitation—apparently the earliest method ever tried to produce polyploidy—seem to be extremely rare. The present report records a case of amphidiploidization by decapitation in a grass hybrid.

During severe winter (December-January), when most of the grasses dry up, it is a general practice to cut the upper portions so that new tillers can arise from the lower nodes. During the winter of 1967, 25 potted plants of an interspecific hybrid, *Pennisetum typhoides* ($2n = 14$) × *P. purpureum* ($2n = 28$), having 21 chromosomes (Fig. 1) were severely pruned. Out of these, two plants, on regeneration, produced some ears which had fertile pollen and also gave good seed-setting. Cytological examination confirmed these plants to be amphidiploids with $2n = 42$ chromosomes (Fig. 2).



FIGS. 1–2. Fig. 1. A PMC of an amphihaploid (*Pennisetum typhoides* × *P. purpureum*) showing diakinesis with $2n = 21$ chromosomes. Fig. 2. A PMC of a decapitation-induced amphidiploid showing diakinesis with $2n = 42$ chromosomes; the parental chromosomes are showing considerable amount of preferential pairing.

Decapitation may not always lead to chromosome doubling, it is nevertheless interesting that sometimes amphidiploids can be obtained by this method. Premeiotic mitotic irregularity leading to somatic chromosome doubling (presumably due to temperature fluctuations at the time of regeneration of the aerial portions) in the amphihaploid plants may have resulted in the production of amphidiploid ears which are largely fertile. Almost regular pairing of truly homologous partners (preferential synapsis) in the amphidiploid sporocytes results in fertile spores and eventually in good seed-setting. Thus, this hybrid can be propagated by seeds also.

Polyploidy is of wide occurrence in the Gramineæ. Polyploids met with in grasses are predominantly alloploids. Interspecific hybridization followed by chromosome doubling is undoubtedly an extremely important evolutionary mechanism in the grass family. In fact natural hybridization among grasses followed by chromosome doubling has led to the evolution of many commercially-important species of crop plants. Stebbins[6] has listed different factors for the high frequency of amphiploidy in grasses: (1) Occurrence of several species together in large numbers gives ample opportunities for hybridization, (2) the production of abundant wind-borne pollen and the existence of self-incompatibility systems promote cross-pollination, (3) most of the species and their hybrids are perennials and have efficient means of vegetative propagation. These factors help in the production, survival and successful establishment of new hybrid combinations. In addition to the above factors, the authors feel that through natural decapitation (severe grazing by wild animals) amphidiploids from the natural interspecific hybrids are being produced and this may also be one of the factors contributing towards the abundance of allopolyploidy in wild grasses.

We are grateful to Dr. D. Srinivasachar for his helpful suggestions.

Division of Genetics,
Indian Agricultural
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PREM P. JAUHAR.
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TEST CROSS METHOD FOR POSSIBLE USE IN CROSS-FERTILIZED AND ASEXUALLY PROPAGATED CROPS

IN breeding varieties of crop plants involving exploitation of hybrid vigour, test crosses are used to determine the combining ability of inbred lines. In diploid species the production of inbred lines involves four to seven generations of selfing and selection. This is difficult, time-consuming and at times even impossible in crops which are tetraploid in nature and/or are asexually propagated, because of several reasons :

(*i*) It takes several more generations of selfing in tetraploid to isolate homozygous lines.

(*ii*) Many asexually propagated plants are tetraploid in nature or have longer life-cycle than one year.

(*iii*) In asexually propagated crops many cultures in selfed progenies do not produce flowers and this restricts selection to flowering types only. Even in flowering types some of the varieties and selfed progenies may be either male-sterile or have low pollen fertility.[1] In maize open-pollinated varieties (instead of inbred lines) have been used successfully to evaluate general combining ability by test cross analysis.[2] This method was tested in potato, which is an asexually propagated and a tetraploid species.

The variety Craig's Defiance was used as a common tester parent against ten varieties and cultures to evaluate their general combining ability. The hybrid seedlings were raised and next year the experiment was laid out using C1 tuber material with 25 cultures per hybrid combination planted in three replications. The yield data of ten cross combinations are presented in two ranges, upto 280 g. and above 280 g. Varieties and cultures are listed in decreasing order of yield. Standard deviation and analysis of variance were worked out in Table I.

TABLE I

Yield ranges of cross-bred progenies in first clonal generation having Craig's Defiance as a common female tester parent

Sl. No.	Male parents used	Percentage of plants in each yield range Upto 280 g.	Over 280 g.	Average yield per plant in g.	Standard deviation
1	Ultimus ..	21·3	78·7	448·4	199·0
2	Krasava ..	48·0	52·0	316·6	142·6
3	Satha ..	54·8	45·2	305·8	169·7
4	Katahdin ..	57·3	42·7	295·9	140·8
5	C.P. 1395 ..	61·3	38·7	269·8	158·1
6	Croissement ..	71·9	28·1	235·7	131·0
7	Kufri Kundan ..	73·6	26·4	209·8	148·1
8	C.P. 1389 ..	86·7	13·3	155·7	83·3
9	Epron ..	90·0	10·0	140·6	130·6
10	Kufri Neela ..	90·6	9·4	131·4	87·1

S.E. for variety means = 23·6 g. per plant.
C D. (0·05) = 70·2 g. per plant.

With an increase in the percentage of segregates in the higher yield range (more than 280 g.) the average plant yield also increases. High-yielding segregates also showed generally higher standard deviation indicating that these varieties offer better scope for selecting higher yielding segregates.

The variety Ultimus showed the best general combining ability and gave the highest percentage of high-yielding segregates. This study has brought the significance of test cross method in the selection of best combiners by evaluating general combining ability in tetraploid and asexually propagated crops like the potato.

Central Potato Research Institute,
Simla-1 (Himachal Pradesh),
May 1, 1969.

T. R. DAYAL.

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REVIEWS AND NOTICES OF BOOKS

Wave Propagation in a Turbulent Medium. By V. I. Tatarski (Dover Publications, Inc., New York), 1967. Pp. xvi + 285. Price: Paperbound $ 3.25.

This Dover edition, first published in 1967, is an unabridged republication of the Englisn translation originally published in 1961 by the McGraw-Hill Book Company, Inc.

This mathematical monograph, translated by R. A. Silverman, formerly of New York University's Institute of Mathematical Sciences, describes the phenomena associated with the propagation of electromagnetic and acoustic waves through atmospheric turbulence. It approaches the subject from both the theoretical and experimental sides, placing special emphasis on recent Russian contributions—just those contributions which are the least accessible in English. Applications to phase and amplitude fluctuations, the scintillation of stars, radio scattering, and other problems are stressed.

Part I covers some topics from the theory of random fields and turbulence theory, including statistical description. Part II, on the scattering of waves in the turbulent atmosphere, is supplemented with an appendix (scattering of acoustic radiation) by R. H. Kriachnan of New York University. Part III is a detailed presentation of line-of-sight propagation of acoustic and electromagnetic waves through a turbulent medium. And Part IV is a comparison of theory with experimental data including the author's own important work with terrestrial light sources, multiple observations, etc.

This book will be found highly useful by specialists in radiophysics and atmospheric acoustics and optics. Additional notations by the translator, 103 bibliographical references, and 45 figures are all helpful extras. C. V. R.

Physical Metallurgy of Iron and Steel. By Rajendra Kumar. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1968. Pp. xvi + 456. Price Rs. 35·00.

This book builds on the firm foundation of the basic principles of physical metallurgy and demonstrates that a mastery of this logical framework of basic principles can not only supplant but can serve much better than mental documented storage of the properties and characteristics of large numbers of the infinite variations in the composition of steels. Such a mastery of the basic principles leads to a truly scientific appreciation of the potentialities and limitations of various types of steels. Various phase transformations are discussed in the context of heat treatment and in the light of recent research. An extensive bibliography is provided at the end of each chapter.

The topics covered in this book are: Polymorphism of Iron; The Iron-Carbon System; Alloying Behaviour of Iron; Solidification of Steel; Formation of Austenite; Decomposition of Austenite; Pearlitic Transformations; Bainitic Transformations; Martensitic Transformations and Hardening of Steels; Precipitation Processes and Tempering; Strengthening of Steels; Ageing and Precipitation in Iron and Low Alloy Steels; and Embrittlement of Steels.

This book will serve both as a text for students and a work of reference for research workers and metallurgists in the field.

C. V. R.

Number Concepts and Geometry. By G. Cuthbert Webber and John A. Brown. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1), 1969. Pp. xi + 416. Price 84 *sh.*

This book represents a revision of the authors' *Basic Concepts of Mathematics* with the addition of material on logic and geometry. The additional material has been class-tested for several semesters; students who have worked through the early material on number concepts seem to handle the logic and geometry readily.

This textual material was written specifically for the elementary school teacher, either prospective or in-service. The aim is to give the reader both comprehension and mastery of arithmetic and basic geometry, so that he can present mathematics as a meaningful body of ideas rather than as a set of isolated techniques to be learned by rote. To this end, properties and their application are stressed; for example, the reader analyzes the algorithms for arithmetic operations in terms of number properties.

The contents of this book are: Numeral Systems; Sets and Numbers; Operations and Their Properties. Sentences.—Part 1: Addition of Whole Numbers; Part 2: Notation and Sentences; Part 3; Other Operations and Properties. Computations: The Application of Properties; Special Methods. Division Theorem; Primes and Divisibility; Fractions; Logic, Proof and Truth Sets—Part 1: Logic and Proof; Part 2: Truth Sets; Applications; Geometry—Part 1: Formal Geometry; Part 2: Informal Geometry; Plane Figures and Separation; Negative Numbers. Rational Numbers; Real Numbers; Measurement: A Mathematical Approach; Measurement in Practice; Mathematical Systems; and Special Topics.

C. V. R.

Lectures on Integral Equations. (*Van Nostrand Mathematical Studies*—17). By Harold Widom. (Van Nostrand, Reinhold Company, New York, Toronto, London, Melbourne), 1969. Pp. iii + 124. Price $ 3.50.

The main results of integral equation theory are obtained as consequences of the theory of operators on Banach and Hilbert spaces (although a short account of Fredholm's original approach is given). The development is self-contained; however, the reader is expected to have an acquaintance with elementary real variable theory including the elements of Lebesque integration. Applications are also given to second-order linear differential equations, while a final chapter uses Fourier integral techniques to investigate certain singular integral equations of interest for physical applications as well as for their own sake.

C. V. R.

Invariant Means on Topological Groups. (*Van Nostrand Mathematical Studies*—16). By Frederick P. Greenleaf. (Van Nostrand, Reinhold Co., 450, West 33rd Street, New York, N.Y., 10001), 1969. Pp. viii + 113. Price $ 3.50.

The notes in this book have been prepared for both graduate students and working mathematicians whose interests include functional analysis and the theory of topological groups. The book deals with the notion of Banach invariant mean, which has classical origins in real analysis. Many interesting applications to solve contemporary problems are brought together. Recent developments are presented with a brief account of the subject and the basic theory underlying current research.

C. V. R.

New Journals

Organic Magnetic Resonance (Vol. 1, Issue 1). (Heyden and Son Ltd., Scientific and Technical Publishers, Spectrum House, Alderton Crescent, London N.W. 4), February 1969. Subscription Price £ 16-10-0 or $ 40.00 per annum.

Organic Magnetic Resonance is a Bi-monthly International Journal specifically devoted to magnetic resonance phenomena as applied to organic chemistry. It will include papers on NMR, NQR and ESR and the more recently developed technique of ion cyclotron resonance (ICR). A special feature of the journal is the *Spectral Supplement* which is supplied along with the main issue. This contains in standard format full original spectra of compounds, reported in the papers, together with experimental details. Papers may be written in English, French or German.

The first issue under review is of 92 pages and contains seven original papers of which three are in English, two in French and two in German. English abstracts are provided for each paper. The Spectral Supplement of 52 pages depict nearly sixty spectra.

The get-up of the journal is excellent, and the Spectral Supplement being issued separately, will gradually grow to form a useful collection for reference work.

A. S. G.

Information Sciences, Vol. 1, No. 1, December 1968. Editor: John M. Richardson. (American Elsevier Publishing Company, Inc., 52, Vanderbilt Avenue, New York, N.Y. 10017), 1968. Subscription Price: Vol. 1 (4 issues) $ 24.00 + $ 1.00 postage.

This is an international journal devoted to the publication of papers dealing with the various subject areas generally categorised as "information sciences". Thus the list will include: Statistical Prediction and Filtering; Communication Theory; Information Theory; Machine Translation; Mathematical Linguistics; Pattern Recognition; Identification of Systems; Self-Organising Systems; Adaptive Control; Stochastic Processes and Coding Theory.

The first issue of the journal under review contains the following papers: Direct Conversion of Observational Histories into Control Signals; Stratification and Control of Large Systems with Applications to Chess and Checkers; Gradient, Error-Correction Identification Algorithms; Least-Square Methods in Abstract Pattern Recognition; On Optimal Stochastic Control with Smoothed Information; and Theory of Transformation Groups of Polynomials over GF(2) with Applications to Linear Shift Register Sequences.

A. S. G.

ANNOUNCEMENTS

Symposium on "Macromolecules in Storage and Transfer of Biologica Information"

The Symposium on "Macromolecules in Storage and Transfer of Biological Information" organized by the Biology and Medical Committee of the Department of Atomic Energy will be held at Bhabha Atomic Research Centre, Trombay, Bombay-58, about mid-December 1969. The Scientific programme will include sessions on: Ultrastructure of Cells and Electron Microscopy of DNA, Nucleic Acid Structure and Function, Transcription and Translation of Nucleic Acids, Regulatory Mechanisms, Function of Cellular Membranes, Nature and Repair of Radiation Damage. The last date for sending abstracts for contributed papers is September 30, 1969. The abstracts may be sent to Dr. M. K. Notani, Biology Division, Bhabha Atomic Research Centre, Trombay, Bombay-85.

Third Convention of the Indian College of Allergy and Applied Immunology

The Third Convention of the Indian College of Allergy and Applied Immunology will be held in Maulana Azad Medical College, New Delhi, on 20th and 21st December 1969 under the Chairmanship of Prof. R. Viswanathan. Those interested in presenting papers, etc., are requested to write to Dr. (Mrs.) Satish Arora, Department of Pharmacology, Maulana Azad Medical College, New Delhi, by 30th September 1969. During the Convention a symposium on "Allergic Skin Manifestations" will also be held.

Indian Society of Endocrinology and Metabolism

The next Annual Conference of the Indian Society of Endocrinology and Metabolism will be held in Bombay in January 1970 along with that of the Association of Physicians. Those who would like to join this Society are requested to write to Dr. J. C. Patel, Secretary, Indian Society of Endocrinology and Metabolism, Back Bay View, New Queen's Road, Bombay-4.

Award of Research Degrees

Osmania University has awarded the Ph.D. degree in Chemistry to Shri Mohd. Ehsan and Shri T. N. Parthasarathy; Ph.D. degree in Technology to Shri Y. V. Subba Rao.

The Sambalpur University has awarded the Ph.D. degree in Chemistry to Shri Sarweshwar Guru.

Sri Venkateswara University has awarded the Ph.D. degree in Physics to Shri T. V. Ramakrishna Rao and Shri M. J. Kesava Murthy; Ph.D. degree in Botany to Shri N. Sreeramulu.

Utkal University has awarded the Ph.D. degree in Mathematics to Shri Jyotirmoy Sinha Roy.

Andhra University has awarded the Ph.D. degree in Geology to Shri A. S. Naidu; Ph.D. degree in Chemistry to Shri K. Venugopala Rao; Ph.D. degree in Nuclear Physics to Shri T. Nagarajan and Shri V. V. Rama Murthy.

The M.S. University of Baroda has awarded the Ph.D. degree in Geology to Shri Vinayak Narayan Kulkarni; Ph.D. degree in Microbiology to Shri Autar Krishan Mattoo, Shri Bipinchandra Manubhai Desai and Shri Karri Lakshmi Narayana; Ph.D. degree in Zoology to Kumari V. N. Shyamalakkuttyamma.

Books Received

The Mutants of Maize. By M. G. Neuffer, Loring Jones and Marcus S. Zuber. (Crop Science Society of America, 677, South Segoe Road, Madison, Wisconsin, 53711, U.S.A.), 1968. Pp. vi + 74. Price not given.

X-Rays in Theory and Experiment (2nd Edn.). By A. H. Compton and S. K. Allison. (Affiliated East West Press P. Ltd., C 57, Defence Colony, New Delhi-3), 1969. Pp. xiv + 828. Price Rs. 34·00.

Refrigeration on Fishing Vessels. By J. H. Merritt. [Fishing News (Books) Ltd., 110, Fleet St., London E.C. 4], 1969. Pp. 148. Price £ 2/12/6.

Supplement to Glossary of Indian Medicinal Plants, By R. N. Chopra, I. C. Chopra and B. S. Varma. (CSIR Publication and Information Directorate, Hillside Road, New Delhi-12), 1969. Pp. xii + 119. Price Rs. 14·00 or Sh. 28, or $ 4.50.

1348-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,

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Current Science is the Premier Science Fortnightly of India published by the Current Science Association, Bangalore, and issued on the 5th and 20th of each month. All material intended for publication in CURRENT SCIENCE (Articles not exceeding 2,000 words and Letters not exceeding 500 words, with brief abstracts and minimum number of illustrations to stand column size reduction) and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

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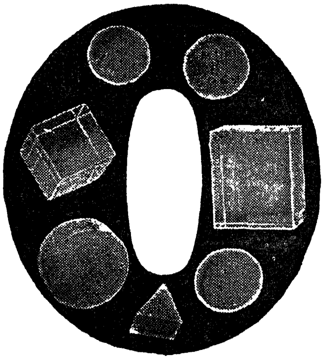

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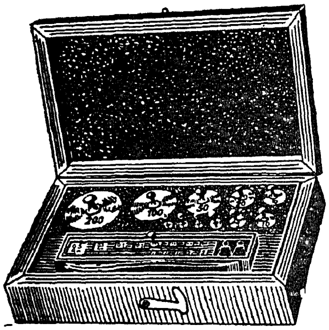

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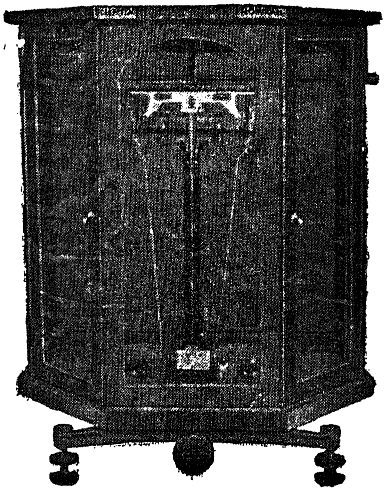

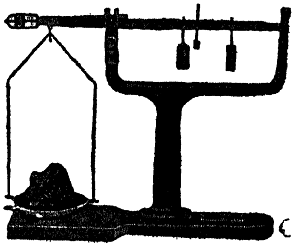

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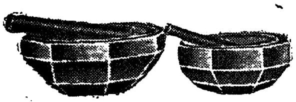

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PREPARATION OF 5, 6-CELLULOSEEN FROM CELLULOSE NITRATE OF LOW DEGREE OF SUBSTITUTION (D.S.)

W. B. ACHWAL AND S. D. DESHPANDE
Department of Chemical Technology, University of Bombay

ABSTRACT

5, 6-Celluloseen of a high degree of unsaturation has been prepared starting from cellulose nitrate containing 7·2% nitrogen, by a series of reactions involving iodination and dehydroiodination. The product obtained was found to be a mixed polysaccharide containing 5, 6-glucoseen, 3, 6-anhydro-D-glucose and D-glucose units similar to the product from cellulose nitrate of high D.S. Determination of free hydroxyl groups in celluloseen is not possible by acetylation as the double-bond takes part in reactions depending upon the conditions of acetylation. The above starting material is preferable in view of the safe handling as well as easier isolation of intermediate compounds.

INTRODUCTION of new types of functional groups into cellulose macromolecule constitutes one of the most interesting and promising trends in modifying the properties of cellulose. The presence of unsaturation in the basic unit of cellulose macromolecule would offer the possibility of attaching new groups directly to the pyranose ring of cellulose. Preparation of such a cellulose derivative containing unsaturation, *e.g.*, 5, 6-celluloseen and some chemical transformations of double bond by hydrogenation and radical addition reactions, have been recently carried out.[1,2]

5, 6-Celluloseen prepared from cellulose tosylate as a starting material contains tosylate residues which cannot be easily removed without loss of unsaturation. 5, 6-Celluloseen prepared from cellulose nitrate of high D.S. (degree of substitution) has been shown to be free from nitrate groups.[3] Cellulose nitrate of high D.S. is, however, difficult to prepare and is highly combustible and explosive in nature. The preparation of 5, 6-celluloseen involves replacement of nitrate groups at C_6 by iodine and subsequent dehydroiodination along with hydrogen at C_5. Hence, if sufficient nitrate groups are present in C_6 position cellulose nitrate of low D.S. may equally serve as a good starting material for preparation of 5, 6-celluloseen. Murray and Purves[4] have shown that in cellulose nitrate of low D.S. at least one-half of the nitrate groups are at C_6. As the amount of accompanying oxidation probably depends upon the degree of nitration, preparation of 5, 6-celluloseen from cellulose nitrate of low D.S. may result in a product with lesser degradation.[4] Hence, in the present work cellulose nitrate of D.S. ≃ 1 was used as a starting material and conditions have been standardised for introduction of high degree of unsaturation. The composition of the celluloseen product obtained has been established by chromatographic and infra-red methods, and compared with celluloseen obtained from cellulose nitrate of high D.S.

Cellulose nitrate of D.S. ≃ 1 was prepared by using a nitrating mixture ($H_2SO_4 + HNO_3 + H_2O$), the composition of which was selected after various trial experiments. Cellulose nitrate was then subjected to iodination in acetone solvent as suggested previously.[3] The dehydroiodination of the resulting 6-iodo-deoxy cellulose nitrate was carried out with alcoholic potassium hydroxide solution for various reaction periods at room temperature and also at 65° C. The maximum unsaturation introduced at both temperatures was of similar order suggesting that increase in temperature had only an effect of accelerating the rate of dehydroiodination. Analysis of typical products at different stages are summarised in Table I.

TABLE I

Original cellulose nitrate		6-Iododeoxy-cellulose nitrate				5, 6-Celluloseen				
Nitrogen (%)	D.S. (ONO_2)	Iodine (%)	D.S. (iodine)	Nitrogen (%)	D.S. (ONO_2)	Bromine No.	D.S. (double bond)	Iodine (%)	Nitrogen (%)	% Iodine replaced by double bond
7·16	**1·07**	**30·0**	**0·52**	**1**	**0·16**	**31**	**0·31**	**≃0**	**≃0**	**58**
12·50	**2·25**	**37·7**	**0·71**	**1**	**0·17**	**39**	**0·37**	**≃0**	**≃0**	**50**

The unsaturation introduced in both celluloseen products starting from cellulose nitrate of low as well as high D.S. is of comparable order. The percentage of iodine replaced by double bond is higher in celluloseen product starting with cellulose nitrate of low D.S. Residual nitrate groups in iododeoxy-cellulose nitrate are found to be removed simultaneously. The formation of double bonds is not quantitative in both the cases suggesting the presence of side reactions.

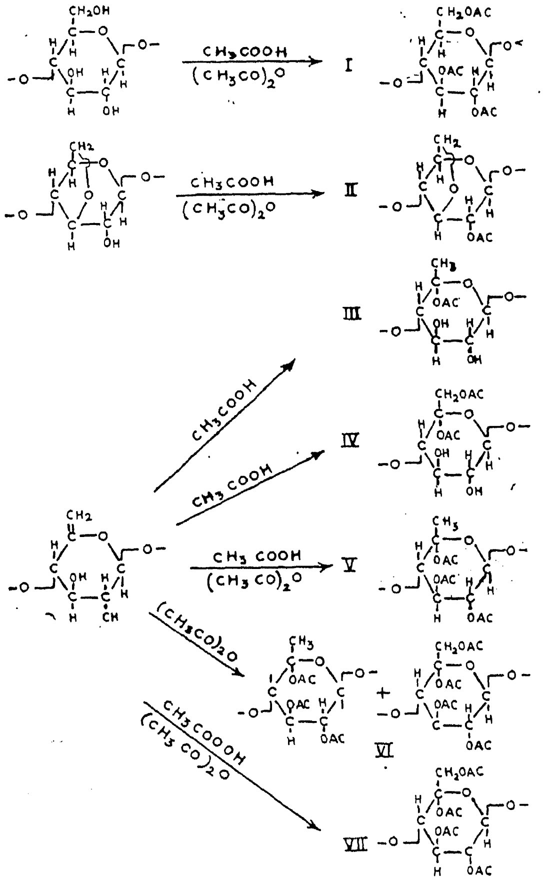
Chromatographic and infra-red studies of 5, 6-celluloseen prepared from cellulose nitrate of low D.S. showed it to be a mixed polysaccharide containing elementary units of 5, 6-glucoseen, 3, 6-anhydro-D-glucose and D-glucose as in the preparation from high D.S. cellulose nitrate. As the percentage of iodine converted into double bond is more in the former, the side reaction, *viz.*, formation of anhydro ring between C_6 and C_3 would be of a lesser order. Preparation of cellulose nitrate of low D.S. is moreover quite simple as compared to that of cellulose nitrate of high D.S. and the product is safer to handle and store. Retention of fibrous structure during iodination of cellulose nitrate of low D.S. considerably simplifies the isolation of all the intermediate products. 5, 6-Celluloseen prepared from cellulose nitrate of low D.S. had a higher D.P. as compared to product from cellulose nitrate of high D.S. as observed from copper number values.

In order to get further information about the structure of 5, 6-celluloseen prepared from cellulose nitrate of low D.S. as well as its reactivity, it was subjected to acetylation under different conditions. Analysis of the products are summarised in Table II.

TABLE II

Sample	Acetylating agents	Bromine No.	D.S. (double bond)	Acetyl No.	D.S. (acetyl)
5, 6-Celluloseen	..	31	0·31	0	0
„	(1) Acetic acid	4	0·04	8·5	0·25
„	(2) Peracetic acid	0	0	15·0	0·47
„	(3) Standard acetylation	4	0·04	32·0	1·20
„	(4) Acetic anhydride	3	0·03	46·0	1·90
„	(5) Peracetic acid + standard acetylation	0	0	55·5	2·40
Standard cellulose	(1) Acetic acid	0	0	0	0
„	(3) Standard acetylation	0	0	62·0	2·90
„	(5) Peracetic acid + standard acetylation	0	0	62·0	2·90

In order to understand the total effect, the reactions of different acetylating agents with the three elementary units in 5, 6-celluloseen product have to be considered. D-glucose as well as 3, 6-anhydro-D-glucose units are not likely to undergo any reaction with acetic acid and peracetic acid as can be seen from the values for standard cellulose. These two components can react with acetic acid and acetic anhydride mixture in presence of catalyst, forming 2, 3, 6-triacetyl glucose and 2-acetyl, 3, 6-anhydro-D-glucose units respectively as shown by reactions I and II. Hence, difference in values of acetyl number in celluloseen must be attributed to the reaction of 5, 6-glucoseen unit only. 5, 6-glucoseen can add on acetic acid leading to the formation of 6-deoxy-5-acetyl glucose (III). Peracetic acid is known to introduce hydroxyl groups into olefins.[5,6] During the reaction of peracetic acid with celluloseen, glycol formation may take place at the double bond which would get acetylated forming 5, 6-diacetyl glucose (IV). Under standard acetylation conditions involving pretreatment with acetic acid followed by reaction with acetic anhydride, acetic acid may be initially adding to the double bond as shown by reaction III and other hydroxyl groups get subsequently acetylated giving 6-deoxy 2, 3, 5-triacetyl glucose units (V). When acetic anhydride alone is used, the reaction is likely to be complex. Acetic acid is bound to be formed as a result of acetylation and can itself take part in the reaction. A higher value for acetyl number with acetic anhydride alone as compared to standard acetylation, indicates the possibility of oxidation of double bond of 5,6-glucoseen unit by perchloric acid used as a catalyst leading to formation of epoxy type ring and its subsequent opening up and acetylation of hydroxyl groups produced giving a complex product containing 6-deoxy, 2,3,5-triacetyl glucose and 2,3,5,6-tetracetyl glucose (VI). The highest value is obtained on treatment with peracetic acid followed by standard acetylation procedure leading to the formation of 2,3,5,6-tetracetyl glucose units (VII).



Although it is obvious that some of the above reactions may not be taking place quantitatively and reaction products may be unstable, the reactions proposed above can explain satisfactorily the observed acetyl number values under different acetylation conditions. The above results also show that the standard acetylation procedure for estimation of hydroxyl groups in cellulose derivatives is not applicable when unsaturation exists in the elementary glucose unit of cellulose macromolecules.

---

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FREQUENCY DISTRIBUTION OF MAGNITUDES OF VISUAL METEORS OBSERVED DURING NOVEMBER, DECEMBER AND JANUARY 1960-67

M. SRIRAMA RAO, P. V. S. RAMA RAO AND B. LOKANADHAM

Meteor Research Laboratory, Physics Department, Andhra University, Waltair (A.P

VISUAL meteors have been systematically observed since November 1960 by the group of workers from the Meteor Research Laboratory, Waltair.[1-2] A total of 8,326 meteors have been observed during the period November, December and January 1960–67, including 339 during November 1960, 4,106 during November, December and January 1961–64 and 3,881 during November, December and January 1964–67. The aim of the present investigation is to study the frequency distribution of the apparent visual magnitudes of these observed meteors.

The data of 8,326 meteors are classified into groups of different observed apparent visual magnitudes (M). Fig. 1 shows the histogram of variation of the number of meteors in each group *versus* the corresponding values of M. It may be seen from this histogram that the 3rd, 4th and 5th magnitude meteors are the largest number observed, and that the number falls off steadily for brighter meteors. This is because the naked eye limit is the 5th magnitude, and long before this limit is reached, the observer will begin to miss meteors. Furthermore, the observer's effective field of view for a bright meteor is much greater than for a faint one, and this is one of the major factors contributing to the fall off in numbers with increasing magnitude. An attempt is now made to correct for this effect and obtain the true distribution of meteor magnitudes.

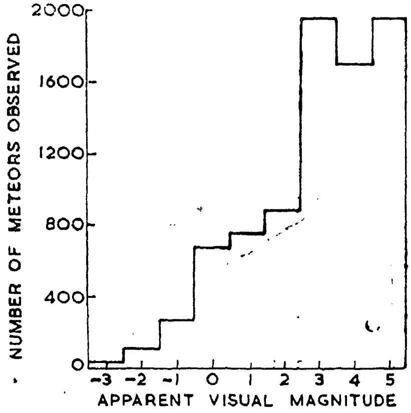

FIG. 1

Millman worked out a factor '*f*' by the total number of meteors by any gr observers should be multiplied in order the value for a standard group of six vers (*see* Mc Kinley[3]). Millman believ his standard team of six observers sho all zero magnitude meteors but less of magnitude meteors. He also worked factor 'F' by which the observed should be multiplied to yield the true of meteors that would be observed if no is missed as above. Thus the true of meteors 'Q_M' that would be observed standard group of six observers per hou be computed from the observed hou 'q_M' by applying the above two cor Thus we have

$$Q_M = F.f.q_M$$

In actual practice, the correction fa is first applied to each period of obs made by any group of observers in o standardise the data for the group observers. Thus we get the data of of meteors for each apparent visual ma (M) corresponding to different per observation. By summing up these for each value of M and dividing the the number of hours observed in all, the mean hourly rate of meteors '$f.q_M$' standard group of six observers. Th of '$f.q_M$' thus computed for the se period are presented in Fig. 2 as curve curve of log $f.q_M$ *vs.* M is found to be li bright meteors upto the zero magni tends to become more and more cur fainter meteors. The correction fact then applied for the mean hourly meteors '$f.q_M$' to obtain the true hour of meteors Q_M for the standard grou observers, and the results are pres curve B in Fig. 2 itself. The plott of log Q_M *vs.* M are found to be almost displaced, and hence the best fit strai is drawn passing through these point least square method. This straight li be represented by the equation

$$\log Q_M = \log Q_0 + M. \log r$$

or

$$Q_M = r^M. Q_0$$

where Q_0 is the value of Q_M at M zero, and log r is the slope of the strai graph. The constant r is defined as the factor by which the true hourly rate of meteors of any magnitude increases for a unit increase in the apparent visual magnitude. The value of Q_0 and r derived from Fig. 2 are 1·3 and 2·4 respectively. The corresponding mean hourly rates for a single observer, say n_M, may then be obtained by dividing the six observer rates by 3·3 (*see* Mc Kinley[3]). The value of n_0, for the present observations, is thus found to be 0·4.

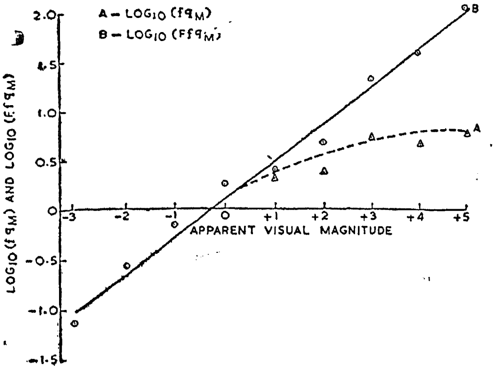

FIG. 2

The value of r is an important index, which indicates the relative abundance of meteors of different magnitudes. Mc Kinley[3] indicated that the value of r lies between 2·5 and 4·0. The present value of 2·4 lies at the lower limit of this range. An attempt is also made to derive the value of r for some important major shower meteors observed during this period of observation. These results are presented in Table I. It may be seen from this table that the values of r for the Taurids and the Geminids are in close agreement with that of all the meteors observed. The value of r for the Leonids is, however, relatively low as has already been indicated by Lovell[4] from Millman's observations. This indicates relative abundance of brighter meteors in the Leonid stream.

TABLE I

Values of r for shower meteors

Shower meteors	Duration of activity	Number of meteors observed	Value of r
Taurids	November 1–30	1,447	2·5
Leonids	November 15–20	1,046	1·8
Geminids	December 6–19	1,714	2·4

ACKNOWLEDGEMENT

The authors wish to express their deep sense of gratitude to the Council of Scientific and Industrial Research for financial assistance.

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SUCCESSFUL ARTIFICIAL PROPAGATION OF *HILSA ILISHA* (HAMILTON) NEAR ALLAHABAD

J. C. MALHOTRA, P. K. MATHUR, M. YUSUF KAMAL, RAVISH CHANRDA AND V. R. DESAI

Central Inland Fisheries Research Sub-Station, Allahabad

IN view of the commercial importance of the Indian Shad, *Hilsa ilisha* (Hamilton), and the reported dwindling of its fishery due to physical barriers across rivers,[1] various attempts were made to artificially propagate hilsa at several places in this country,[2-8] but none succeeded in rearing the resultant hatchlings beyond three days. However, Karamchandani[9] was able to hatch fertilised hilsa eggs collected from the Narmada and rear the hatchlings upto fourteen days. An attempt was, therefore, made at artificial propagation of hilsa through stripping and hypophysation at Sirsa on the Ganga, about 50 km. downstream of Allahabad.

Live male and female specimens, which were procured from commercial catches of 'Kamel' (clap net), were simultaneously stripped on to enamel trays containing 22 mm. deep river-water. The trays were then gently tilted from side to side for about five minutes. All the fertilised eggs turned transparent in about fifteen minutes.

In all, eight strippings were attempted, all of which proved successful. They were invariably undertaken late in the evening, since initial examination revealed that fish in oozing condition were available only in the afternoon catches. The length of the females employed ranged from 380 to 480 mm., while that of the males varied from 316 to 448 mm. It was observed that one male was more than sufficient to fertilise the eggs stripped from a single female. In one experiment, the live female was partly stripped and the eggs were got fertilised successfully with the milt of a male which had died about 30 minutes earlier. In another experiment with the same female 30 minutes after its death, all of its remaining eggs were stripped and mixed with the milt of two males, one partly spent and the other oozing. It was again successful. In both these cases, about 90% of the eggs were found to have been fertilised.

To start with, enamel trays containing 50 mm. deep river-water were employed for hatching the fertilised eggs; but they proved of little use, as 98% of the eggs died after about eight hours of development, possibly due to the steep fall in temperature of the tray water from 28° C. to 16° C. For all the subsequent hatchings, double-walled hapas, usually employed for hatching carp eggs, were employed. They were fixed in the river-bed close to the bank at a place where the depth was about 1·0 m. and a mild current was available all the time. The inner hapa of round meshed mosquito netting, employed to segregate dead eggs and egg shells from the hatchlings, proved of no value, as all the hilsa eggs invariably passed through the 2 mm. mesh of the inner hapa. An inner hapa made from 1/16" meshed cloth was tried experimentally, but with no better results. Thereafter, single-walled hapas of markin cloth were put into commission and the hatchlings segregated mechanically, taking advantage of the direction of the flow.

The resultant hatchlings were successfully reared in the river in markin cloth hapas, fixed adjacent to the hatching hapas, for periods ranging from 7 to 20 days, and thereafter two samples, one of 50,000 hatchlings and the other of 75,000 hatchlings, were transferred to two freshwater nursery ponds (90′ × 70′ each) for further rearing. The remaining hatchlings were released in the river. In 20 days of river rearing, the first batch of 2·5 to 3·0 mm. long hatchlings grew to 10 mm. size, while the second batch attained a size of 7·5 to 8·0 mm. in seven days. In nursery ponds, the post-larvæ of the first batch attained a size of 22 mm. in 45 days, while those of the second batch grew to 20 mm. in 30 days. Sudden intense cold killed all these early fry after the above periods of rearing. In all, the first batch of hatchlings could be reared for a total duration of 65 days and the second batch for 37 days. Successful rearing of hilsa larvæ after artificial fecundation over such long durations was thus achieved for the first time.

Preliminary experiments, conducted to adjudge the possibilities of transporting hilsa spawn under oxygen in sealed containers, indicated that yolked larvæ could be successfully transported under oxygen packing with relatively little mortality.

Experiments were also conducted to induce breed hilsa through hypophysation, employing pituitary glands of *Hilsa ilisha*, *Cirrhina mrigala*, and *Wallago attu*, preserved in absolute alcohol or acetone, at temperatures ranging from 7° C. to 8° C. Double distilled water was employed to prepare the extract. As the injected fish could not be kept alive beyond 4½ hours under captivity, no tangible results could be achieved by this method.

To keep hilsa alive under captivity, an essential prerequisite to breed it through hypophysation, and to circumvent certain situations in stripping experiments, such as the availability of individuals of only one sex at a time, hapas of different materials and dimensions were tried. It was possible to keep the fish alive for only about 4½ hours, and the hapa found most useful was the one made from bamboo splits and measured 185 cm. in length, 105 cm. in width and 135 cm. in height. It was fixed in river-bed close to the bank at a spot where the water depth was about 100 cm. and a mild current was available all the time.

Our thanks are due to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, for his keen interest, helpful suggestions and encouragement during the progress of these investigations. Thanks are also due to Shri H. P. C. Shetty for his valuable suggestions and constant help and to Dr. Y. R. Tripathi, Director of Fisheries, Uttar Pradesh, for providing facilities to rear hilsa in ponds.

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LETTERS TO THE EDITOR

A NOTE ON SPINNING de SITTER MANIFOLD

In recent years de Sitter manifolds have become interesting especially with regard to their applications in particle physics.[1-4] In this connection it may be of some interest to find a spinning manifold pertaining to this universe. Newman and Janis[5] have shown that a line element equivalent to the Kerr metric[6] can be derived by means of a complex co-ordinate transformation over Schwarzschild metric. The resulting metric then represents the metric of a spinning object. This method may also be applied for finding a spinning line element pertaining to the de Sitter manifold. The line of approach is reported below. Starting with the de Sitter line element[7],

$$dS^2 = \left(1 - \frac{r^2}{R^2}\right) dt^2 - \left(1 - \frac{r^2}{R^2}\right)^{-1} dr^2 - r^2 (d\theta^2 + \sin^2 \theta d\phi^2), \tag{1}$$

with

$$\frac{1}{R^2} = \frac{\wedge}{3},$$ $\wedge$ being the cosmological constant,

one can make use of the following co-ordinate transformation

$$u = t + \frac{1}{2} ln \frac{(R-r)}{(R+r)}, \quad r' = r, \ \theta' = \theta, \ \phi' = \phi, \tag{2}$$

for obtaining a line element equivalent to (1) in the following form :

$$dS^2 = \left(1 - \frac{r^2}{R^2}\right) du^2 + 2dudr - r^2 (d\theta^2 + \sin^2\theta d\phi^2). \tag{3}$$

Here one defines

$$x^0 = u, \ x^1 = r, \ x^2 = \theta, \ x^3 = \phi. \tag{4}$$

The contravariant components of the metric (3) are

$$g^{00} = 0, \ g^{11} = -\left(1 - \frac{r^2}{R^2}\right), \ g^{10} = 1,$$
$$g^{22} = -r^{-2}, \ g^{33} = -r^{-2} \sin^{-2} \theta. \tag{5}$$

These components then can be written in the form

$$g^{\mu\nu} = l^\mu n^\nu + l^\nu n^\mu - m^\mu \bar{m}^\nu - m^\nu \bar{m}^\mu, \tag{6}$$

with

$$l_1^\mu = \delta_1^\mu, \ n^\mu = \delta_0^\mu - \frac{1}{2}\left(1 - \frac{r^2}{R^2}\right) \delta_1^\mu,$$

$$m^\mu = \frac{1}{\sqrt{2} r} \left[\delta_2^\mu + \frac{i}{\sin \theta} \delta_3^\mu\right],$$

and

$$\bar{m}^\mu = \frac{1}{\sqrt{2} r} \left[\delta_2^\mu - \frac{i}{\sin \theta} \delta_3^\mu\right]. \tag{7}$$

One then allows the co-ordinate r to take complex values. The tetrad (7) can then be rewritten in the form

$$l^\mu = \delta_1^\mu, \ n^\mu = \delta_0^\mu - \tfrac{1}{2}\left[1 - \frac{r\bar{r}}{R^2}\right] \delta_1^\mu,$$
$$m^\mu = \frac{1}{\sqrt{2} \bar{r}} \left[\delta_2^\mu + \frac{i}{\sin \theta} \delta_3^\mu\right],$$
$$\bar{m}^\mu = \frac{1}{\sqrt{2} r} \left[\delta_2^\mu - \frac{i}{\sin \theta} \delta_3^\mu\right], \tag{8}$$

$\bar{r}$ being the complex conjugate of r.

On performing the following complex co-ordinate transformation

$$r' = r + ia \cos \theta, \quad \theta' = \theta,$$
$$u' = u - ia \cos \theta, \quad \phi' = \phi, \tag{9}$$

On the vectors l^μ, n^μ and m^μ, $\bar{m}'^\mu$ being the complex conjugate of m'^μ, one can get the desired spinning line element corresponding to (2). If one now allows r' and u' to be real, one then obtains the following tetrad with the use of (9) in (8):

$$l'^\mu = \delta_1^\mu,$$
$$n'^\mu = \delta_0^\mu - \frac{1}{2} \left[1 - \frac{(r'^2 + a^2 \cos^2\theta)}{R^2}\right] \delta_1^\mu,$$
$$m'^\mu = [\sqrt{2} (r' + ia \cos \theta)]^{-1} \times \left[ia \sin \theta (\delta_0^\mu - \delta_1^\mu) + \delta_2^\mu + \frac{i}{\sin \theta} \delta_3^\mu\right], \tag{10}$$

and

$$\bar{m}'^\mu = [\sqrt{2} (r' - ia \cos \theta)]^{-1} \times \left[ia \sin \theta (\delta_1^\mu - \delta_0^\mu) + \delta_2^\mu - \frac{i}{\sin \theta} \delta_3^\mu\right].$$

The following metric

$$g'^{\mu\nu} = l'^\mu n'^\nu + l'^\nu n'^\mu - m'^\mu \bar{m}'^\nu - m'^\nu \bar{m}'^\mu, \tag{11}$$

will then represent a spinning manifold pertaining to the de Sitter universe. The contravariant

$$g^{\mu\nu} = \left|\begin{array}{cccc} -a^2 x \sin^2\theta & (r^2+a^2)\, x & 0 & -ax \\ \cdot & [\mathrm{R}^{-2} x^{-1} - (r^2+a^2)\, x] & 0 & ax \\ 0 & 0 & -x & 0 \\ \cdot & \cdot & 0 & -x \sin^{-2}\theta \end{array}\right|$$

and

$$g_{\mu\nu} = \left|\begin{array}{cccc} \left(1 - \frac{1}{x\mathrm{R}^2}\right) & 1 & 0 & a x^{-1} \mathrm{R}^{-2} \sin^2\theta \\ \cdot & 0 & 0 & -a \sin^2\theta \\ 0 & 0 & x^{-1} & 0 \\ \cdot & \cdot & 0 & -\sin^2\theta\, (r^2 + a^2 + a^2 x^{-1} \mathrm{R}^{-2} \sin^2\theta) \end{array}\right|$$

where

$$x = [r^2 + a^2 \cos^2 \theta]^{-1}.$$

and covariant components of the metric (11) are given above.

Department of Physics,
University of Rajasthan,
Jaipur, India, *May* 2, 1969.

N. K. SHARMA.

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ROTATIONAL ANALYSIS OF THE C_1 SYSTEM OF SbF

THE spectrum of SbF as investigated by previous workers[1-3] is known to consist of A_1, A_2, A_3 systems in the visible and B, C_1, C_2, C_3 systems in the ultraviolet. From the results of the vibrational analysis of various systems in SbF, it has been concluded that the common lower state X_1 (612·6 K.) of the A_2, A_3, B, C_2 and C_3 systems is the ground state of the SbF molecule. The common lower state of the A_1 and C_1 systems was designated as X_2 (616·9 K.) by Prasada Rao and Tiruvenganna Rao. The X_1 and X_2 levels were tentatively identified with ${}^3\Sigma^-$ and ${}^1\Sigma^+$ states of the configuration

$$..\,(z\sigma)^2\,(y\sigma)^2\,(x\sigma)^2\,(w\Pi)^4\,(v\Pi)^2\,..\ {}^3\Sigma^-, {}^1\Sigma^+, {}^1\Delta.$$

However, the transition involved in any of the above systems has not so far been confirmed from a study of the rotational analysis.

Of the three systems C_1, C_2, C_3 of SbF in the ultraviolet, the C_1–X_2 system lying in the region λ 2550 to λ 2750 proved convenient for a study of the rotational structure in order to establish the nature of the transition involved. The 0, 0 and the 0, 1 bands of the C_1–X_2 system excited in a R.F. discharge have been photographed in the second order of 21-ft. concave grating spectrograph having a dispersion of 0·62 Å/mm. using Kodak 103—a 0 plates.

Examination of the 0, 0 band, shown in Fig. 1, revealed the presence of three branches P, Q and R of which the Q branch is the most intense. The P branch is found to be very weak while the R branch is observed to be strong even at high J values. In the 0, 1 band the P branch is found to be very weak, while the Q and R branches are observed with considerable intensity. These features strongly suggest that the bands arise from a ${}^1\Pi$–${}^1\Sigma$ transition. The J numbering is fixed by a comparison of the upper state combination differences R(J)–Q(J) of the common level $v' = 0$. Simultaneous agreement of the combination differences for P, Q, R branches of the (0, 0) band has also been obtained.

The rotational constants of the upper and the lower states have been determined by following well-known graphical procedures and are summarised in Table I. No Λ-type doubling in the upper state could be detected as the combination defect is found to be negligibly small. The doubling of Q and R branch lines at high J values in the (0, 0) band was attributed to the isotopic effect due to the less abundant molecule ^{123}SbF. The

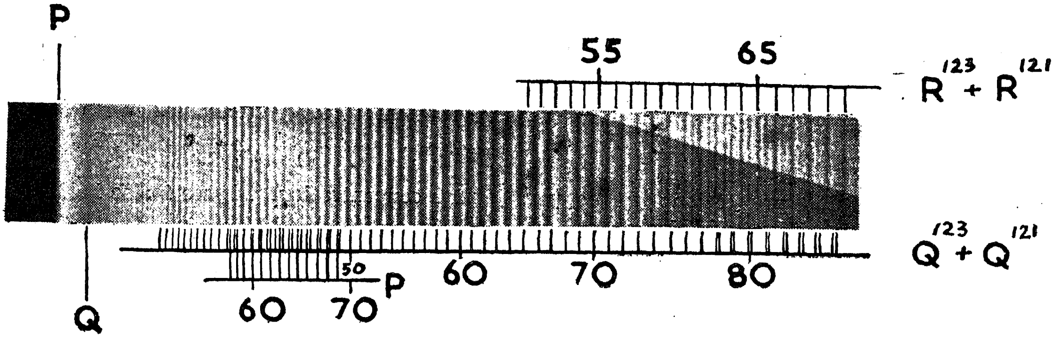

FIG. 1. 0, 0 band of C_1 system of SbF.

TABLE I

Rotational constants of the upper and lower states of C_1 system of SbF

$X_2\ {}^1\Sigma$ state	$C_1\ {}^1\Pi$ state
$B_e'' = 0\cdot287_1$ cm.$^{-1}$	$B_0' = 0\cdot303_2$ cm.$^{-1}$
$B_0'' = 0\cdot285_7$ cm.$^{-1}$	$D_0' = 0\cdot3_7 \times 10^{-6}$ cm.$^{-1}$
$B_1'' = 0\cdot283_0$ cm.$^{-1}$	$\gamma_0' = 1\cdot83_0 \times 10^{-8}$ cm.
$D_0'' = 0\cdot3_2 \times 10^{-6}$ cm.$^{-1}$	$I_0' = 92\cdot31_8 \times 10^{-40}$ gm.cm.^{2}
$D_1'' = 0\cdot2_7 \times 10^{-6}$ cm.$^{-1}$	
$\alpha_e'' = 0\cdot002_7$ cm.$^{-1}$	
$\gamma_e'' = 1\cdot89_0 \times 10^{-8}$ cm.	
$I_e'' = 97\cdot49_5 \times 10^{-40}$ gm cm.^{2}	

upper ${}^1\Pi$ state can be attributed to a configuration of the type.

$$\ldots (z\sigma)^2\ (y\sigma)^2\ (x\sigma)^2\ (w\Pi)^4\ (v\Pi)\ \ldots ns\sigma \ldots\ {}^1\Pi$$

in which an electron goes from an antibonding ($v\Pi$) orbital to a non-bonding $ns\sigma$ orbital of the Rydberg type resulting in an increase in the vibrational frequency of this state (696·8 K.) relative to the ground state X_1 (612·6 K.).

Spectroscopy Lab., Ch. SIVAJI.
Dept. of Physics, P. TIRUVENGANNA RAO.
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ULTRASONIC STUDIES OF COMPLEX FORMATION: SEMI-CARBAZIDE HYDROCHLORIDE AND COPPER CHLORIDE

COMPRESSIBILITY variations associated with the complex ion formation in mixtures of electrolyte solutions have been reported by Satyavati *et al.*,[1] using an ultrasonic interferometer. Their results show a positive excess compressibility at a mole fraction of 0·666 of potassium halides in the corresponding halides of cadmium and zinc, which has been explained on the basis of complex ion formation of the type Zn X_4^{--} and Cd X_4^{--}.

Mario Nardelli *et al.*[2] studied the crystal structures of *mono* and *bis* semi-carbazide complexes of copper and zinc chlorides by X-ray methods. Single crystals of these compounds are obtained by mixing molar solutions of semi-carbazide hydrochloride and copper chloride or zinc chloride in 1 : 1 and 2 : 1 proportions. Studies on chelate compounds and organo-metallic complexes by ultrasonic methods have not been reported so far. The authors have therefore taken up the studies of the aqueous solutions of semi-carbazide copper chloride in order to investigate the complex formation in these solutions.

The absorption of sound in the solutions is measured using a pulse technique as developed by Pinkerton[3] at a frequency of 22·5 mc./s. and could be measured with an error of 3%. The velocity measurements are made by a double crystal variable path acoustic interferometer, working at the same frequency with an accuracy of ± 0·2%.

The absorption and velocity of aqueous solutions of individual components, semi-carbazide hydrochloride and copper chloride (supplied by B. D. H.) have been first studied upto a concentration of 1 mol./litre. The observations revealed normal behaviour in both absorption and velocities for both the components.

Saturated solutions of semi-carbazide hydrochloride and copper chloride are first prepared by dissolving them in distilled water at room temperature. Different proportions of copper chloride solutions are then added to that of semi-carbazide hydrochloride and velocity and absorptions are made at each concentration. The results are shown in Fig. 1. But when saturated solutions of these compounds are mixed, a precipitate is formed above 1·0 molar concentration of copper chloride. For all such concentrations giving a precipitate, observations are made after adding distilled water to just dissolve the precipitate. The results, as shown in Fig. 1, indicate two minima in the absorption curve at the concentration values corresponding to the formation of *mono* and *bis* semi-carbazide copper chloride complexes. However, it is felt that these results are vitiated by the fact that the extra amount of water added at each concentration will reduce the values of velocity and absorption by an unknown amount.

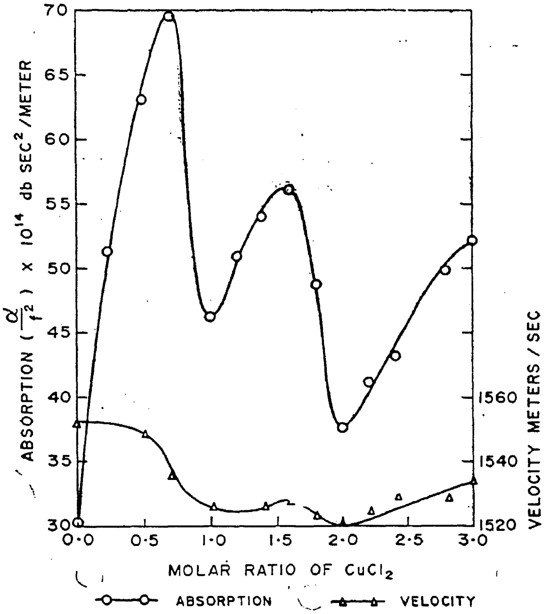

FIG. 1

To avoid this difficulty an unsaturated solution of semi-carbazide hydrochloride (0·3 mol./litre) is taken and different amounts of copper chloride solutions are added. The concentration of semi-carbazide hydrochloride solution is so low that no precipitate is formed for all the concentrations that have been studied and Fig. 2 gives the variation of velocity and absorption with concentration of copper chloride. The amount of copper chloride added is expressed in terms of an equivalent molar concentration. Figure 2 also indicates two minima in the absorption curve and these correspond to the molar ratios of 1 : 1 and 2 : 1 respectively. Thus the two minima can be again associated with the formation of *mono* and *bis* semi-carbazide copper chloride complexes.

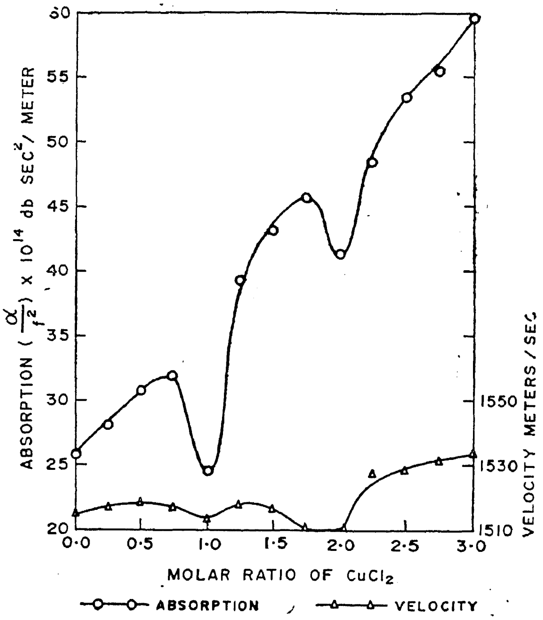

FIG. 2

The increase in absorption with increasing concentration of copper chloride may be due to the increase in number of free ions in the solution supplied by the copper chloride. At those concentrations where *mono* and *bis* complexes are forming, the number of free ions till then present will be reduced resulting in a minimum in absorption.

The velocity curves in both the experiments also indicate the formation of the *mono* and *bis* complexes. The changes in velocity shown in Fig. 2 are not as pronounced as those given in Fig. 1 but definitely indicate minima in velocity at concentrations which are required for the formation of the *mono* and *bis* complexes. The increase in the compressibility values at these concentrations can be understood by the fact that due to the formation of complexes there is a reduction in the number of free ions in these solutions and therefore they have become more compressible.

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Department of Physics, M. VENKATESHWARLU.
Osmania University, G. SIVARAMA SASTRY.
Hyderabad-7, (A.P.) *May* 16, 1969.

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HAEMOGREGARINA AEGYPTIA, MOHAMMED AND MANSOUR (1963); A BLOOD PARASITE OF *BUFO REGULARIS* IN THE SUDAN

THIS parasite was first discovered in *Bufo regularis* in Khartoum and described briefly under the name *Hæmogregarina tunisiensis* Nicolle.[1] The same parasite was also known from the same host in Nigeria and the Congo.[2,3] Later, the parasite was reported from toads in Egypt and a careful study of the morphological features of the parasite indicated that it is different from *H. tunisiensis* and it was assigned to a new species, *viz.*, *H. ægyptia*, Mohammed and Mansour (1963).[4]

In the present study, 53 toads (*Bufo regularis*) were examined for their blood parasites and 40 were found to be infected with Hæmogregarines. Out of these infected toads, 20 (50%) were hosts of *Hæmogregarina ægyptia*. Of these, 14 were infected with *H. ægyptia* alone, whereas 6 were also infected with *H. boueti*, Franca (1910).

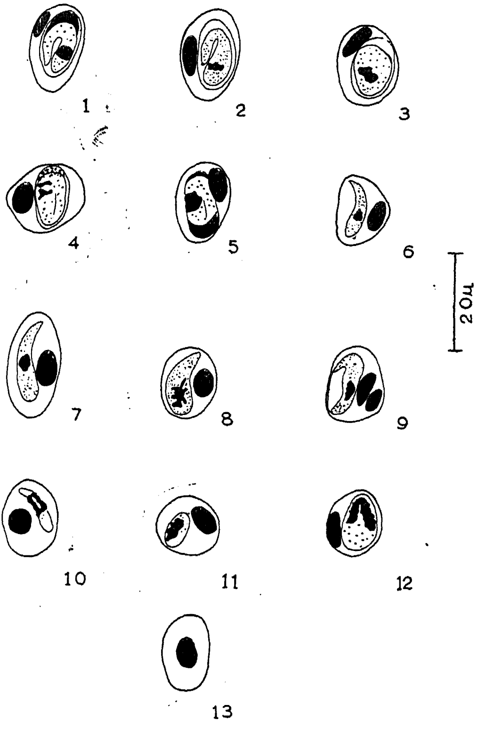
Four forms of the parasite were found in the blood of the infected toads.

1. *The Capped form* (Figs. 1-5): This is the most frequent form seen in the blood and it is typically a folded vermicule. The parasite is bent on itself thus forming two limbs of approximately equal length. One limb may be slightly narrower than the other, which is broader and contains the nucleus. In some parasites both limbs are of the same width and still in others, the limbs may be inconspicuous and the parasite is tightly packed in the host cell.

The nucleus is spherical, oval or crescent in shape and in stained preparations with Giemsa, it is usually the same colour as nucleus of the host cell.

The parasite is enclosed in a delicate capsule in the host cell. This capsule is usually conspicuous and twice as long as broad. It measures 12·7–14·7 μ × 6·7–8·6 μ (Mean: 13·7 μ × 8·1 μ).

At the curved end of the parasite, there is an area which stains a deep red colour with Giemsa and fits over the parasite as a cap. This cap is a characteristic and constant feature of this form of the parasite. In understained films, this cap may appear as an empty area (Fig. 3) while, in lightly stained material, a number of red granules appears (Fig. 4) and with progressive staining, these granules gradually increase in number and finally the entire cap is completely stained. On rare occasions some parasites were observed with two caps (Fig. 5).



FIGS. 1-13. *Hæmogregarina ægyptia*. Figs. 1–5. Mature Capped Forms. Figs. 6–9. Elongated and Intermediate Forms. Fig. 10. Thin Young Form. Fig. 11. Oval Young Form. Fig. 12. Broad Form. Fig. 13. Normal Red Blood Corpuscle of *Bufo regularis*.

Differences were occasionally observed in the staining reactions of different parasites in the same blood film. Sometimes the cytoplasm stained very dark blue and had a granular appearance while in others the cytoplasm was not granular and stained light blue with a pinkish tint. These differences are most probably due to sexual dimorphism of these forms of the parasite.

2. *Elongated and intermediate forms* (Figs. 6-9).—Some elongated parasites were also recorded with the typical capped forms. These varied greatly in length, and usually extended throughout the length of the red host cell, pushing its nucleus to a marginal position. These forms measured 14–17 μ (Mean : 16 μ) in length with a maximum breadth of 4–5·3 μ (Mean : 4·8 μ). Some of the forms were gradually acquiring the typical bent and capped forms (Fig. 9). The nuclei of these forms were spherical, oval or rosette in shape. They measured 2·7–4 μ (Mean : 3·2 μ) in diameter.

3. *Young forms* (Figs. 10, 11).—These were of two main types:

(*a*) *Thin forms*: These are thin, spindle-shaped with tapering ends. Their nuclei were always large when compared to the size of the parasite. These parasites measure 7·3–10·7 μ × 3·3–4·0 μ (Mean : 9·6 μ × 3·5 μ).

(*b*) *Oval forms*: These are oval with homogeneous, clear cytoplasm and larger less compact nuclei. They measure 8–9 μ × 4·6–5·3 μ (Mean : 8·7 μ × 4·8 μ). Despite their small size these forms usually push the nucleus of the host cell to a marginal position.

4. *Broad forms* (Fig. 12): These are relatively large broad parasites with diffused nuclei which occupy the entire breadth of the parasites. They measure 10·6–12 μ × 7·3–8 μ (Mean : 11·2 μ × 7·6 μ). The nucleus of the host cell is usually pushed in close contact with the plasma membrane of the infected erythrocyte.

Infected corpuscles are invariably hypertrophied. All forms of the parasite, irrespective of their size caused a significant displacement of the nuclei of the infected corpuscles and occasionally these nuclei were even fragmented.

The cytoplasm of the infected erythrocytes usually stained lightly when compared with that of non-infected corpuscles and this was more evident in host cells with mature infections. This is probably caused by gradual dehæmoglobinization of the cytoplasm of the infected corpuscles.

It is evident from the previous description that the various forms of the parasite comprise a continuous series in the development of this organism. Thus, the encapsulated capped forms represent gametocytes which have probably developed from thin young forms after passing through the intermediate elongated stage. The broad type may represent an early schizogonic stage in the blood of the host.

When the features of the present parasites are compared with those reported by Mohammed and Mansour (1963) for the capped hæmogregarines of *Bufo regularis* in Egypt, it becomes evident that all of them belong to the same species *Hæmogregarina ægyptia*. Originally, it was thought that the presence of a single cap in *H. ægyptia* might differentiate this species from *H. tunisiensis* Nicolle which has two caps.[4] However, on some occasions the present writers observed that some parasites had caps at both ends of the capsule and for this reason this character should not be used to separate these two species of hæmogregarines. At the same time, it appears that the other differences given by Mohammed and Mansour are sufficient to separate these two species.

It is clear from the present description that Stevenson's identification of the capped, bent hæmogregarines from *Bufo regularis* in Khartoum as *H. tunisiensis* cannot be accepted.

Department of Zoology, SAADIA A. YOUNIS.
University of Khartoum, M. F. A. SAOUD.
Sudan, *April* 5, 1969.

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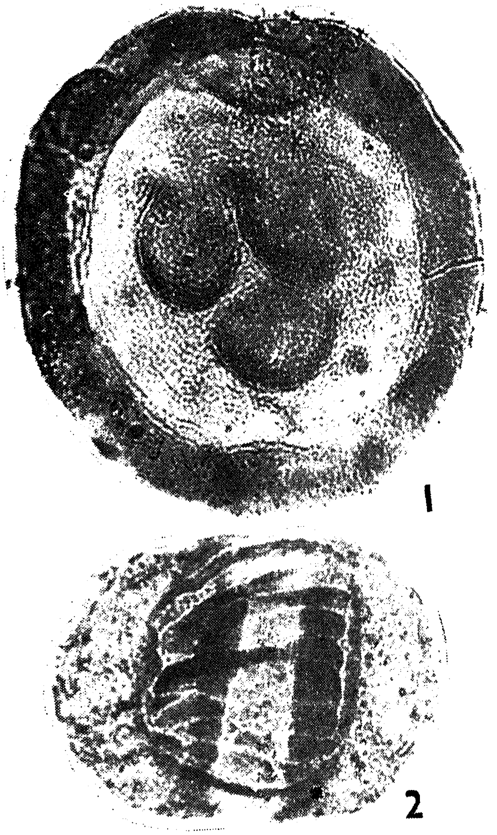
DISCOVERY OF TALCHIR MIOSPORE FLORAS IN THE JAYANTI COALFIELD, BIHAR

THE Jayanti basin is a small area east of the Giridih Coalfield, exposing mostly the Talchir and Karharbari (or Barakar) formations.[1,2] The present note is meant to record the discovery of well-preserved miospore assemblages from the Talchir sequence exposed in the Patharjore Nalla. Of particular significance is the finding of spores from the Boulder Beds which occur repeatedly in the Talchir sequence, for nothing was hitherto known about the palynological history of the Talchir Boulder beds, which are related with Gondwana glaciation.

In general, the miofloras abound in monosaccate miospores (*Plicatipollenites, Virkkipollenites, Parasaccites, Potoniéisporites, Limitisporites,* etc.) as in other Talchir spore assemblages.[3] Disaccates, simple triletes and monocolpates are uncommon. About 93 species belonging to 43 taxa have been recognized in the whole assemblage. When compared in details, the Jayanti mioflora appears distinct owing to the presence of a number of additional miospores which were so far unknown from the Talchirs. Curiously enough, some of these miospore taxa are apparently more prevalent in the younger miofloras (Karharbari–Barakar Stages). A complete account of the Jayanti miofloras would be published elsewhere.



FIGS. 1-2, × 500.

Some of the sporomorphs of the Jayanti assemblage have revealed new taxonomic features. Of particular interest are two saccate miospores whose peculiar morphology is briefly sketched below. A full paper on these new taxa is already under publication.[4]

The first type (Fig. 1) is a monosaccate miospore with a distinct to indistinct body. No tetrad mark is observed. The spore is characterized by a variable number of conspicuous knob-like protuberances on the proximal body exine. The processes are separate or coalescent. The saccus is thick and its roots are disposed in paracondition. The name *Tuberisaccites* has been proposed for this new sporomorph.[4]

The other miospore type (Fig. 2) is disaccate having a clear to obscure body of variable shape. The body bears proximally a number of nearly horizontal grooves (striations) which may be branched and/or anastomosed. The unique feature is that the horizontal striations do not extend up to the body equator, because they are encircled by another connecting groove which runs ± close and parallel to the body periphery. None of the striate Gondwana miospores exhibit this peculiar encircling groove which apparently restricts the horizontal grooves. A comparable feature is found in *Complexisporites* Jizba[5] but that genus is distinct in having a prominent proximal cap and other distinguishing features. A new generic taxon, *Circumstriatites*, is proposed for the new sporomorph of the Jayanti assemblage.[4]

Birbal Sahni Institute of Palæobotany,
53, University Road,
Lucknow, (U.P.), *May* 21, 1969.

K. M. LELE.
REHANA KARIM.

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A KARYOTYPIC STUDY OF THE ESTUARINE FISH *BOLEOPHTHALMUS BODDAERTI* (PALLAS) WITH CALCIUM TREATMENT

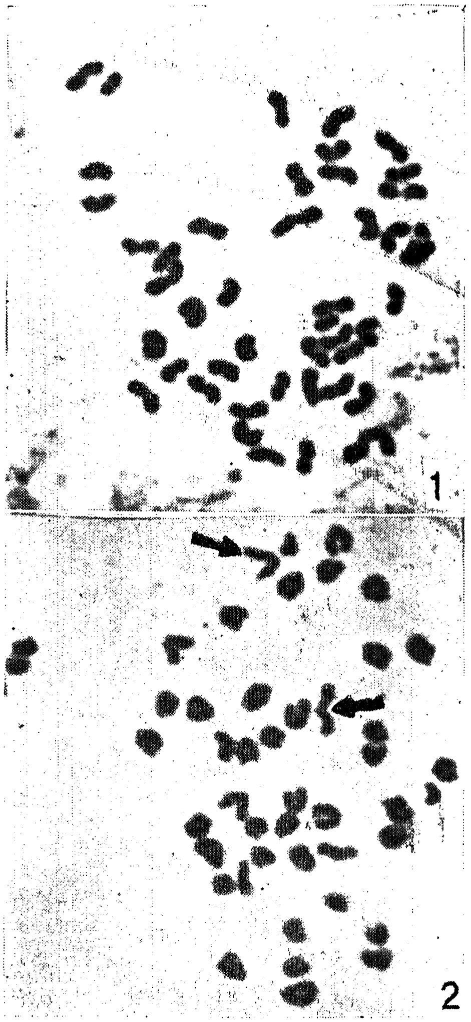
IN recent years, colchicine has been used successfully in the study of fish chromosomes.[1-5] In plants it is known that calcium is necessary for continued mitotic divisions.[6] A number of authors have reported that the divalent calcium ion has influence on mitotic rate in rat thymus and bone marrow, in both irradiated and normal animals.[7-11] The correlation between growth and cell division after calcium treatment has been studied to some extent by Perris, Whitfield and Tölg.[12] But calcium treatment does not seem to have so far been tried for chromosome studies in fishes. The present note reports the very promising results which were obtained with the calcium treatment for demonstrating the chromosomes of the estuarine mud skipper, *Boleophthalmus boddœrti* (Pallas). Male and female specimens of this fish measuring 18–19 cm. in length were used. The fish were kept in well-aerated aquaria in brackish well-water (Salinity 1·2–1·6‰). The females can be distinguished from the males by differences in the dorsal fin-rays and by the form of the genital papillæ.[13]

An intraperitoneal injection of freshly prepared solution of calcium chloride of 0·1% strength was given. The dosage was varied with the size of the fish as follows:

5–10 cm. ..	0·50 c.c.
10–15 cm. ..	0·75 c.c.
15–20 cm. ..	1·00 c.c.

Three hours after the injection of calcium chloride, 0·2% colchicine solution in distilled water (1·00 c.c./50 g. body weight) was given intramuscularly. The fish was allowed to recover in well-aerated aquaria for 12–16 hours after colchicine injection. It was then sacrificed, and the gill arches from both the sides, the kidneys, and the gonads were dissected out as quickly as possible. The gill arches were dialysed in glass-distilled water, while the kidneys and the gonads in 0·9% sodium citrate solution for 10–15 minutes. The tissues were then directly transferred to 2% acetic-orcein and then squashed. Material from seven specimens was prepared in this way and examined.

The diploid chromosome number of *Boleophthalmus boddœrti* as revealed in somatic (gill, kidney, Fig. 1) as well as gonadial tissues of both sexes is $2n = 46$, all being metacentrics, with median centromeres. The female karyotype consists of a large heteromorphic pair, one being metacentric while the other submetacentric (Fig. 2). Whether these are really concerned in sex-determination can be decided only after further investigation. However, the presence of heteromorphic chromosomes in the female of *Boleophthalmus boddœrti* is very interesting. In *Glossogobius giuris* (H.B.) the karyotype, as reported by Kaur and Srivastava,[14] consists of 46 rod-shaped acrocentrics and with no heteromorphic chromosomes.



FIGS. 1–2. Photomicrographs of mitotic metaphase chromosome complement of *Boleophthalmus boddœrti* (Pallas), from (1) Kidney of male and (2) Ovary (large heteromorphic pair indicated by arrows), × *ca.* 4,600.

Injection of calcium chloride proved valuable for obtaining a number of mitotic plates in the kidneys and the gonads of the fishes. Further, the chromosomes did not contract much after calcium treatment as they usually do after colchicine treatment alone. Judging from the experiments reported now, the calcium technique promises to prove valuable for demonstrating fish chromosomes.

I am grateful to Prof. R. V. Seshaiya, Director, for suggesting the problem and guidance and to Dr. R. Natarajan for valuable

suggestions and to Dr. AL. Paul Pandian for help in photography. I am also thankful to the University Grants Commission for the award of a Junior Research Fellowship.

UGC Centre of K. SUBRAHMANYAM.
Advanced Study in Marine Biology,
(Marine Biological Station),
Porto Novo, South India, *May* 22, 1969.

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* Not referred in orginal.

NOTES ON *ALCYONIDIUM ERECTUM* SILEN, 1942 (ECTOPROCTA) FROM THE INDIAN OCEAN

DURING a study of the ectoproctous bryozoans of Indian waters nearly seventy species were recorded hitherto not known from this area. Of these *Alcyonidium erectum* Silen (Ctenostomata) is of special interest. The species has previously been recorded only from the Japanese coast of the Pacific (Silen[1] and Mawatari[2]). Several zoaria of *Alcyonidium erectum* were collected from the appendages and carapace of *Portunus pelagicus* caught in a cast net at 50 fathom depth off Cochin.

Diagnosis.—Zoarium with erect zooids which may be arranged uniserially or biserially growing into sac-like expansions from a basal encrusting portion spreading in a sponge-like fashion (Figs. 1 and 2). Colour of the colonies brown with a greenish tinge when fresh becoming paler in material preserved in formalin. The erect portion develops from the centre of the encrusting part of the colony. The shape of the zooids varies considerably in different situations. Zooecia of the encrusting region usually rectangular in outline becoming much more elongate and sometimes hexagonal. Inter-zooecial walls thicker in the encrusting zooids and thinner in the erect ones. The frontal wall thin, translucent and even. Aperture placed at the distal end of the zooecium, often when the tentacle sheath is not completely withdrawn, giving the appearance of being at the tip of a papilla. In the uniserial and biserial erect regions of the colony the aperture is placed at the tip of a

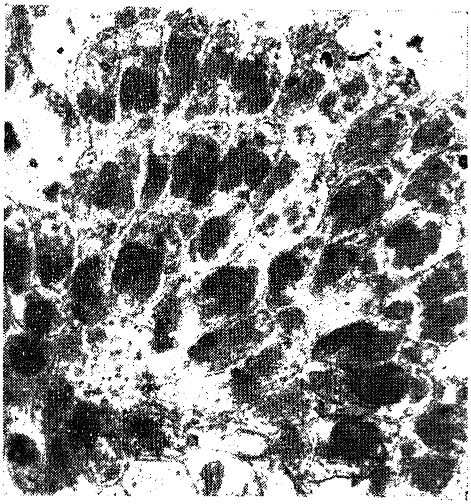

FIG. 1. Encrusting portion of a colony.

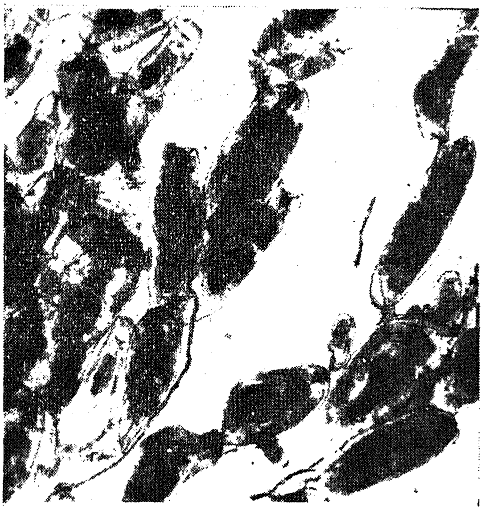

FIG. 2. Erect portion of a colony.

small papilla marked with two to three wrinkles. The lophophore is placed at an angle to the frontal membrane. The pleated collar is funnel-shaped. Parietal muscles consist of eleven pairs.

Morphological Notes.—Silen[1] classified the forms coming under the genus *Alcyonidium* into three groups based on their mode of growth, namely, encrusting forms, erect forms without raised apertures, and erect forms with apertures placed at the tip of papillæ where the zooid rows are often disconnected. It is therefore of interest that the present form shows all the above three morphological peculiarities in one and the same colony and in this respect it is unique. The uniserial or biserial arrangement of the zooids in the proximal part of the erect portion in the present form is also of special interest. The structure of the flabellate region agrees with the observation of Silen[1] and Mawatari.[2] The number of tentacles varies. Silen's material shows twenty tentacles, of Mawatari's twenty-two, and the present form only sixteen. The shape of the zooecia is regular in the encrusting portion of the colonies, whereas it is irregular in the erect portion. This may be the result of its peculiar mode of growth. It is also of interest that the zooecial walls differ in thickness in one and the same colony.

Indian Ocean Biological Centre, — N. RAVINDRANATHA MENON.
National Institute of Oceanography,
Cochin-18 (India),
and
The Marine Biological Lab., — N. BALAKRISHNAN NAIR.
University of Kerala,
Trivandrum-7 (India), *May* 31, 1969.

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EFFECT OF SEED EXTRACT OF *HELIOTROPIUM EICHWALDI* STEUD, ON SEED GERMINATION OF *PHASEOLUS AUREUS* ROXB.

SEEDS of *Heliotropium eichwaldi* Steud have a prolonged dormancy which can be broken by the application of gibberellic acid in dark.[1] This suggests the presence of an inhibitor in this seed.

The inhibitor was extracted by soaking 1,000 seeds, weighing 1·08 g, in 25 ml. distilled water for 24 hr. at 38° C. The dried matter from the extract was finely ground and dissolved in distilled water. Seeds of *Phaseolus aureus* (var. 24–2) were used as the test material. These were germinated in 10 ml. each of five different concentrations of extract under continuous light, alternate 12 hr. light-12 hr. dark, and continuous dark conditions. Osmotic pressure of all the five concentrations of seed extract was noted by conductivity bridge for verifying its interference with germination. The difference in osmotic pressure of the extract was not much to affect germination (0 = 0·014, 25 = 0·022, 50 = 0·027, 75 = 0·035 and 100 = 0·037 atm.).

Germination of *Phaseolus aureus* seeds show gradual decrease under continuous light condition with the increasing concentration of seed extract while reverse is the case under continuous dark condition. Under the condition of dark-light (12 : 12 hr.) there is no sequential pattern of seed germination (Table I). It is, thus clear that the seed extract of *Heliotropium eichwaldi* contains some chemical compound which gets activated in light and acts as inhibitor and under dark conditions as growth promoter for the seed germination of *Phaseolus aureus*. Recently,[2] a water-soluble substance was extracted from the seeds of *Trifolium subterraneum* which in high concentrations adversely affected its own

TABLE I

Effect of different concentrations of water-soluble seed extract of Heliotropium eichwaldi *Steud. on the seed germination of* Phaseolus aureus *Roxb.*

Concentrations* of seed extract	% seed germination†		
	Continuous‡ light	Alternate light and dark (12 : 12 hrs.)	Continuous dark
0	78·3	75·6	72·3
25	69·6	71·0	75·3
50	57·6	72·3	79·0
75	47·3	71·6	81·3
100	39·3	60·3	67·3
C.D. (P=0·01)	3·758	1·673	3·019
(P=0·05)	2·583	1·053	2·075

* Relative concentration (100=1 ml. extract/16 ml. distilled water).

† % germination based on 100 seeds each in 3 replicates. Observations recorded after 8 days based on emergence of both plumule and radicle.

‡ Fluorescent tube light (4′ length) of 40 W and a 200 W Incandescent bulb, placed at a distance of 10′ from the test material.

and also those of wheat seed germination, which is dependent on temperature.

Dept. of Botany and Plant Pathology, ASHWANI K. SRIVASTAVA.
Punjab Agricultural University,
Ludhiana, India, *April* 10, 1969.

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STOMATAL ABNORMALITIES IN *PENNISETUM*

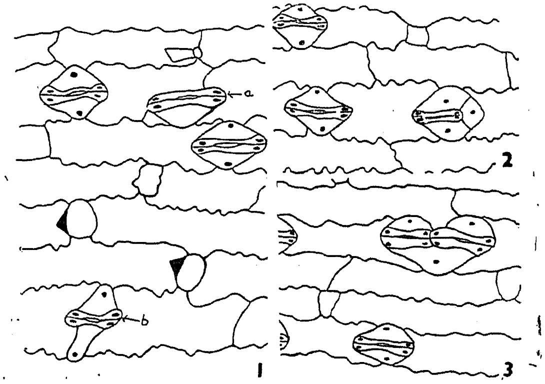
A NUMBER of workers have reported stomatal abnormalities in leaves from normal plants and from plants which have received some treatment (Weber,[9] Weissenbock,[10] Brat and Weber,[3] Dehnel,[4,5] Inamdar[7] and Rao and Ramayya[8]). Dutta and Mukerji have also described abnormalities in stomatal structures in *Datura* while Ahmed[1,2] has done so in some other species of Solanaceæ.

For the present study on epidermal pattern in certain species of *Pennisetum*, pieces from the middle region of the mature leaves were collected, stomata from its abascial surface were studied. A number of abnormalities were observed in some varieties of *Pennisetum typhoides*. The normal stomatal apparatus comprises of a pair of guard cells forming a single stomatal opening and is supported by two subsidiary cells. But along with these normally constituted stomatal structures, there were also found some abnormalities. The abnormal stomata had either a single subsidiary cell (Fig. 1 *a*) or three subsidiary cells (Fig. 2) or two stomata were associated with three subsidiary cells (Fig. 3).

Variation in the structure of subsidiary cells is quite common and it could be observed even in those stomata where the number of subsidiary cells was normal. Normally, the subsidiary cells are more or less semicircular, but the abnormal ones may be transversely elongated (Fig. 1 *b*) or one of them may be smaller than the other. When they are three in number, the cells are not exactly semicircular, and when three subsidiary cells are associated with two stomata, one of them which is common to both is bigger, while the other two associated individually with one of the stomata are relatively smaller in size and have semicircular appearance.

The counting of the abnormal stomata per unit area has revealed that the percentage of different abnormal types varies in the different varieties of *Pennisetum typhoides*.

A perusal of Table I shows that the first four varieties have abnormalities varying from 1% to 2%, while rest of the varieties show between 0·01% and 0·1% only. Thus, on the basis of the percentage of abnormality two distinct groups can be made, *i.e.*, one with slightly higher percentage of abnormal stomata and the other with lower percentage.



FIGS. 1-3. Fig. 1 *a*. Stomata with one subsidiary cell. Fig. 1 *b*. Stomata with an elongated subsidiary cell. Fig. 2. Stomata with three subsidiary cells. Fig. 3. Two stomata associating three subsidiary cells.

TABLE I

Percentage of abnormal stomata in different varieties of Pennisetum typhoides

S. No	Name of the variety	Type of abnormalities: Stomata with one subsidiary cell	Stomata with three subsidiary cells	Two stomata associated with three subsidiary cells	Total
1	Aligarh local ..	1·400	0·410	..	1·810
2	A.E.C.P. ..	1·140	0·700	0·290	2·130
3	Baroda 99 ..	1·400	0·500	0·150	1·900
4	P [illegible]. Pig. ..	0·600	0·310	..	0·910
5	Kota local ..	0·050	0·020	..	0·070
6	R.S.K. ..	0·070	..	0·010	0·080
7	Restorer ..	0·030	0·020	..	0·050
8	K.18 ..	0·050	0·030	..	0·080
9	Jakhrana local	0·057	0·010	..	0·061
10	R S J. ..	0·021	..	..	0·027

In the varieties with higher percentage of abnormal stomata, the gene-controlled developmental processes leading to stomatal formation seem to be rather flexible, while in the varieties with lower percentage of abnormal stomata, they may be least flexible.

I am thankful to Dr. S. P. Singh for valuable suggestions and to the Principal, R.B.S. College, Agra, for providing facilities.

Dept. of Botany, R. P. Yadav.
R.B.S. College, Bichpuri,
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"A PRELIMINARY NOTE ON THE SEX-ORGANS OF *LUNULARIA* SPP." —A CORRECTION

The above note, recently published by T. R. Balachandra Naidu,[1] conveys erroneous data on the plant *Lunularia*. As this plant is taught to post-graduate students at several Indian Universities, the statements in the above communication need correction. "In this genus," the author[1] remarks, "the sex-organs which are similar to those of *Marchantia* have not so far been described." He[1] further states that he investigated the plant ".... with the object of studying the sexual reproduction in the genus about which no previous information is available". If only well-known European manuals on liverworts by Macvicar[2] and Müller[3] had been consulted apart from information available in the classical work by Goebel[4] and an excellent recent publication by Campbell,[5] the author[1] would have refrained from making the above statements. I would lay particularly greater emphasis on the very fine publication by Campbell[5] which gives a very useful account of the sexual reproduction and sex-organs (including sporophyte development) in the genus *Lunularia* growing in New Zealand. Even Kashyap,[6] who could not collect sexual plants of this genus, reproduced the relevant features from the description given by Macvicar[2] and Stephani.[7]

Till recently, the sexual plants of *Lunularia* had not been reported from India. However, in this journal, only two years ago, the male plants of *Lunularia* were described[8] for the first time from India which has obviously escaped the attention of the author.[1]

Department of Botany, Ram Udar.
Lucknow University,
Lucknow, *March* 30, 1969.

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Note on the Sex-Organs of *Lunularia*

The author accepts with sincere thanks, the correction forwarded by Dr. Ram Udar regarding the previous work on *Lunularia*. Owing to the ready unavailability of the references listed the error has crept in.

Central College, T. R. B. Naidu.
Bangalore, *July* 10, 1969.

MEIOSIS IN TRANSLOCATION-DOUBLE TRISOMIC PLANT OF *SORGHUM*

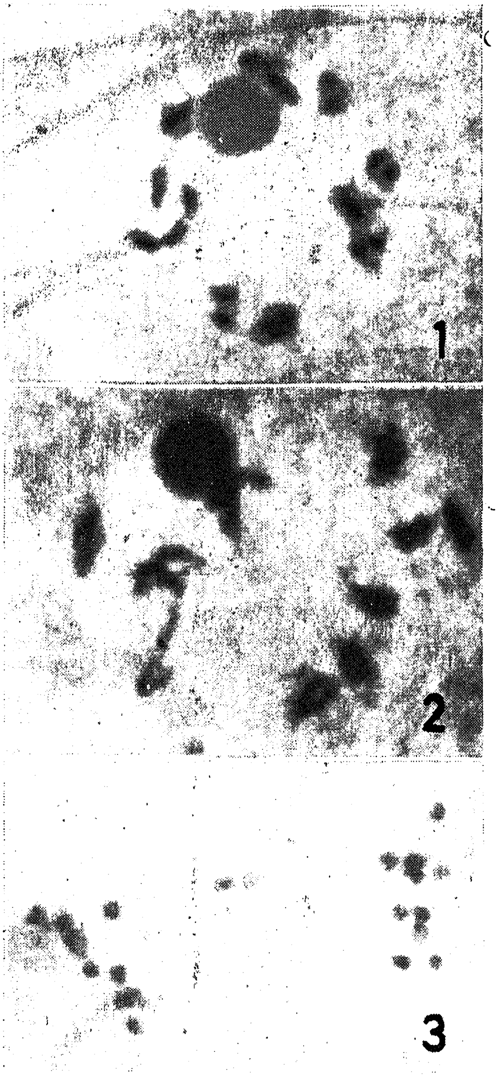
Haploids of grain *Sorghum* ($n = 10$) when outcrossed to related diploids are found to set considerable seed. Among the progenies raised in this way from the two haploid plants of the cultivar Tx 403 (seed material originally from Dr. K. F. Schertz, Texas A and M College, Texas) a small number of plants are found to carry atypical chromosome numbers. One such plant with 22 chromosomes was located among the 85 haploid derivatives cytologically examined. This plant produced greater number of tillers, narrow leaves, short and slightly deformed spikelets on the reduced panicle, and came to flowering 13 days later when compared to diploids of the same cultivar.

Although the occurrence of such a plant was reported previously by Schertz no detailed observations on its cytology have been made.[5] Because of its intrinsic value in gene location studies, results obtained through the analysis of chromosome pairing are reported in this communication. The various types of chromosome associations, observed in 68 diakinesis cells, are presented in Table I. From the data

TABLE I

Frequency of chromosome associations at diakinesis in the 22 chromosomed plant

Associations				Frequency	Percentage
IV	III	II	I		
1	..	9	..	8	11·77
1	..	8	2	5	7·35
..	2	8	..	16	23·53
..	1	9	1	27	39·70
..	..	11	..	3	4·41
..	..	10	2	9	13·24



FIGS. 1-3. Photomicrographs, × *ca* 1,850. Fig. I. Diakinesis showing 2_{III} and 8_{II}. Fig. 2. Diakinesis showing 1_{IV} and 9_{II}. Fig. 3. Anaphase I showing 10-10 segregation of chromosomes and 2 lagging univalents.

it can be made out that 63% of the cells have formed 1 or 2 chains of three chromosomes with 9 bivalents and a univalent or with 8 bivalents (Fig. 1). However, an additional 19% of the cells analysed have shown a chain of four configuration with 9 bivalents (Fig. 2) or 8 bivalents *plus* 2 univalents. For this reason the two extra chromosomes of this plant can be considered to be translocated ones, constituted by arms or parts of the arms, of two different chromosomes in the haploid set. Pairing among 2 pairs of normal and the two translocated chromosomes derived from them, is possible, in various ways. For instance, the formation of chain of four may involve homologous arms of either 1 or 2 translocated members with 3 or 2 normal chromosomes of the plant. In the first case, the two remaining chromosomes of the six may pair in one of their arms to form a rod bivalent while in the second case they remain as univalents being non-homologous. In fact, these two types of associations are found in 12% and 7% of the cells analysed at diakinesis. At anaphsae I, 63% of the cells observed have shown 1 or 2 lagging univalents (Fig. 3).

The origin of this plant may have been through the fertilisation of 12 chromosomed egg formed in the haploid by a normal sperm with 10 chromosomes. Although the formation of chiasmatic bivalents was detected in the haploids of this cultivar[4,5] and other haploid *Sorghums* of divergent origin[1-3] the egg nucleus that functioned in the formation of the present plant appears to have contained all the four chromatids of the chiasmatic bivalent. The plant was found to be highly sterile with 85% sterile pollen as judged by their stainability in acetocarmine.

My sincere thanks are due to Professor J. Venkateswarlu for facilities and encouragement.

Department of Botany,
Andhra University,
Waltair, *May* 17, 1969.

V. R. REDDI.

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FORMATION OF A NEW OLIGOSACCHARIDE IN GUAVA FRUITS UNDER PATHOGENESIS

JUST-RIPE fruits of 'Safeda' variety of guava (*Psidium guajava* L.) were inoculated with *Macrophoma allahabadensis* Kapoor and Tandon and were incubated at 25° ± 1° C. Granger and Horne's method[3] was used for inoculation. The tissue adjacent to the inoculated region was removed and was analysed on every alternate day upto 10 days. Ethanol extract of 2 g. of fresh fruit tissue was prepared. Some uninoculated fruits were also subjected to similar treatments. For the detection of various soluble sugars the chromatographic technique adopted by Ghosh *et al.*[1] was employed. The solvent used was *n*-butanol-acetic acid-water (4 : 1 : 5, upper phase). The intensities of the bands were compared visually and the various concentrations were graded as 3 +, 2 + and +. The — sign indicates the absence of a sugar.

TABLE I

Presence of various sugars in guava fruits during the growth of Macrophoma allahabadensis

Days of incubation	Sucrose	D-glucose	D-fructose	Oligosaccharide R_f 0·30
Uninoculated (Control):				
0, 2, 4, 6, 8	3+	3+	3+	–
10	4+	3+	3+	–
Inoculated:				
0, 2, 4	3+	3+	3+	–
6	Trace	3+	3+	Trace
8	,,	Trace	2+	+
10	,,	,,	+	+

It is evident from Table I that the soluble sugars detected in guava fruits were sucrose, D-glucose and D-fructose. The concentration of sucrose increased with the age of the fruits.

The appearance of an oligosaccharide (R_f 0·30) in the infected guava fruits on the 6th day and its presence upto the end of the incubation period is of considerable interest. The appearance of this oligosaccharide on the 6th day, when a rapid decrease in the sucrose content was observed, indicated that possibly sucrose contributed to the formation of this oligosaccharide. This was confirmed by growing the pathogen on modified Asthana and Hawker's liquid medium 'A'* containing sucrose, whereupon a synthetic oligosaccharide was formed. Several recent studies carried out by Tandon and Bilgrami,[5] Tandon and Chandra,[6] as well as by Kapoor[4] have shown the formation of synthetic oligosaccharides by pathogenic fungi on sucrose solution in culture medium, but the instances of formation of new oligosaccharides in infected fruits are rare. Recently, Ghosh *et al.*[1,2] have demonstrated the production of oligosaccharides during pathogenesis of papaya and mango by *Fusarium* sp. and *Colletotrichum glœosporioides* respectively.

The authors wish to thank the C.S.I.R. for financial assistance to R. N. T. and to the University Grants Commission for the award of a Junior Research Fellowship to I. J. K.

Department of Botany, Allahabad University, Allahabad, India, *May* 2, 1969.
I. J. KAPOOR.
R. N. TANDON.

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* Sucrose, 9·5 g.; KNO_3, 3·5 g.; KH_2PO_4, 1·75 g.; $MgSO_4.7H_2O$, 0·75 g.; distilled water 1 litre.

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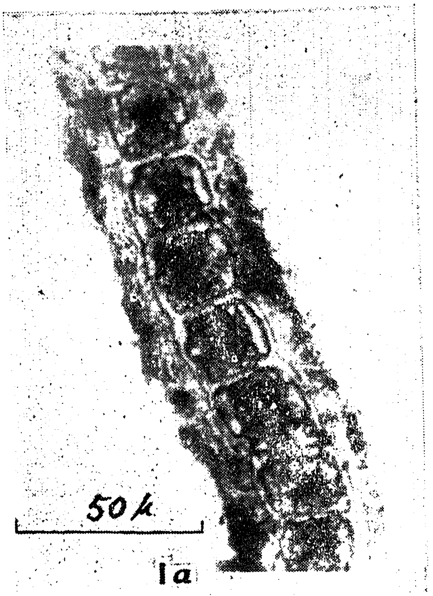
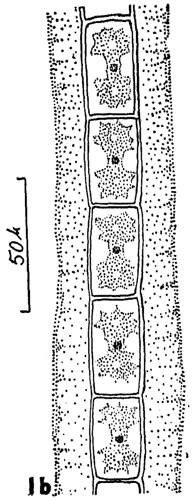
A NOTE ON SHEATH FORMATION IN *ZYGNEMA CZURDAE*

THE filamentous conjugalean members usually possess a narrow, diffluent mucilage sheath which is not visible without special staining (Czurda,[1] Transeau,[2] Randhawa[3]). Such mucilagenous sheaths are generally not very firm or broad. However, firm sheaths have been described in three African species of *Zygnema* by Gauthier-Lievre[4] where the sheaths may be upto 20 μ broad. Such a feature has not been recorded in any Indian form. The present communication is intended to record this feature.

The material of *Zygnema* was collected from a pond near Telibagh about 7 miles from Lucknow in February 1968 (pH of water 9–10). Some filaments showed quite broad and prominent mucilagenous sheaths—their width ranging from 12·5 to 22·5 μ (–37·5 μ) on either side of the cells. The sheaths were very clear even without staining. Staining with methylene blue showed up the non-stratified mucilagenous nature of the sheath (Figs. 1 *a* and 1 *b*). The alga was kept growing in Pringsheim's biphasic soil-water medium,[5] and even after about two months, it retained its sheath. Some of the filaments were fertile and the species has been identified as *Z. czurdæ.*





FIGS. 1 *a* & 1 *b*. *Zygnema czurdæ.* Fig. 1 *a*. Filament showing a broad mucilagenous sheath. Fig. 1 *b*. Camera lucida sketch of a filament showing a non-stratified mucilagenous sheath.

It is too early to assess the value of a firm sheath as a taxonomic character within the group. It also cannot be ascertained at present whether this character is a genetically based constant feature or is a mere response to ecological conditions.

I am indebted to Dr. B. N. Prasad for critical comments and going through the manuscript.

Department of Botany, SHIPRA DUTTA.
Lucknow University,
Lucknow (U.P.), India, *May* 19, 1969.

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A NOTE ON THE DEVELOPMENT OF ENDOSPERM AND EMBRYO IN *UTRICULARIA GRAMINIFOLIA* VAHL

Utricularia is an embryologically heterogeneous member of Lentibulariaceæ. Recently, there have been several reports on the variations in the embryogeny of this genus which consist of the investigations on *U. flexuosa* (Khan, 1954), *U. cœrulea* (Kausik, 1956), *U. arcauta* (Farooq, 1965), *U. uliginosa* (Farooq, 1965) and *U. stellaris* (Farooq, 1967). The present investigation records the endosperm development and the variations in the early development of embryo in *U. graminifolia* Vahl.

The pollen grains germinate on the stigmatic lobes and a number of pollen tubes pass through the stylar canal and creep above the surface of the placenta after reaching the ovarian cavity. The pollen tubes meet the egg cell outside the micropyle and fertilization is effected which results in the destroying of one of the synergids and the formation of a zygote and a primary endosperm nucleus.

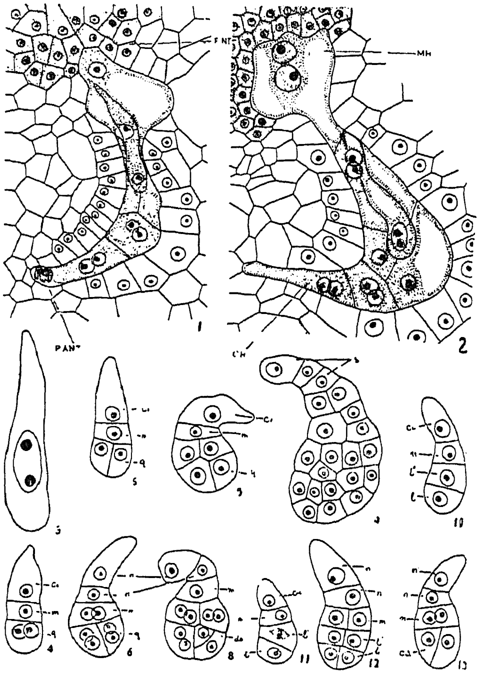
The development of the endosperm is of *ab-initio* Cellular type. The first division of the primary endosperm nucleus takes place in the centre of the embryo sac and is accompanied by a transverse wall. Consequently, the embryo sac becomes divided into two distinct chambers—a primary micropylar and a primary chalazal chamber. The next division in both the chambers is followed by incomplete vertical walls, therefore, the two cells of each chamber are not completely separated from each other. Sometimes the second division is delayed in the chalazal chamber. Each one of the four cells of the endosperm, thus formed, now divides by a transverse wall to form an eight-celled endosperm, the cells of which are disposed in four tiers. The terminal tiers at the micropylar region and the chalazal region function as the micropylar and the chalazal haustoria respectively while the central two tiers give rise to the endosperm proper by further divisions (Figs. 1 and 2). The micropylar haustorium is very aggressive. It is lobed in the beginning but as the haustorium enlarges, the lobed nature is lost. It extends into the placental nutritive tissue, breaking the cells that come in contact with it. It remains two-nucleate throughout the course of development, the nuclei being very large and conspicuous (Fig. 2).

The chalazal haustorium is less aggressive when compared to the micropylar haustorium and lies in the midst of the chalazal nutritive tissue. It consists of two nuclei which migrate to the base of the haustorium in later stages. The antipodals persist upto the early stages of endosperm development and are obliterated later (Fig. 1).

The zygote (Fig. 3) divides only after considerable amount of endosperm tissue is formed. It elongates producing a long tube which penetrates through the endosperm cells. The zygote nucleus lies at the dilated end of the tube in the centre of the embryo sac. The first division of the zygote nucleus is followed by a transverse wall and results in the formation of an apical cell *ca* and a basal cell *cb*. The basal cell *cb* is long and tubular while the apical cell is small. The basal cell invariably undergoes a transverse division to form *ci* and *m* while the divisions in the terminal cell are not uniform. It may divide longitudinally producing two juxtaposed cells *q*, so that the resultant pro-embryonal tetrad is T-shaped conforming to the A_2 series of Soueges classification (Figs. 4 and 5). The quadrants (Fig. 6) divide again to form octants which are disposed in two tiers (Figs. 7 and 8). The middle cell *m* divides vertically twice, to form four cells (Figs. 6 and 7) and contributes towards the formation of hypocotyledonary region (Fig. 9).

In some cases the terminal cell divides by a transverse wall producing a linear proembryonal tetrad (Fig. 10) which fits into the C_2 series of Soueges classification. The cells are designated as *l* and *l'* from *ca* and *m* and *ci* obtained from *cb*. Of these, the cells *l* and *l'* form the embryo proper while a part of the cell *m* or the whole of *m* is utilized for the formation of hypophysis and the hypocotyl regions (Figs. 11 and 12).

In yet other cases an oblique division was observed in the terminal cell which resulted in a tetrad corresponding to the B_2 series (Fig. 13).



FIGS. 1-13. *Utricularia graminifolia* Vahl: Development of endosperm and embryo. Fig. 1 L.S. ovule showing multicellular endosperm, zygote and the persistent antipodals. Fig. 2. L.S. ovule showing multicellular endosperm, zygote and the chalazal and the micropylar haustoria. Fig. 3. Zygote. Figs. 4–5. T-shaped proembryonal tetrads. Figs. 6–9. Stages in the development of embryo. Fig. 10. Linear proembryonal tetrad. Figs. 11-12. Stages in the development of the embryo. Fig. 13. Proembryo showing an oblique wall in the *ca*. (CH, Chalazal haustorium; ENDCLS, Endosperm cells; MH, Micropylar haustorium; PANT, Persistent antipodals; PNT, Placental nutritive tissue.) (All figs., × 300).

A T-shaped tetrad is more frequent when compared to the other types. Irrespective of the shape of the tetrad, the middle cell *m* contributes to the formation of the hypocotyl and further divisions in either case are irregular after the first periclinal division (Figs. 8 and 9). A mature embryo is undifferentiated.

The variations in the development of embryo in *U. graminifolia* Vahl further support the earlier records in other species of *Utricularia* investigated so far.

Department of Botany, MAQBOOL BEGUM.
Maharani's College for Women,
Bangalore, *May*, 15, 1969.

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REVIEWS AND NOTICES OF BOOKS

Encyclopedia of Library and Information Science (Vol. 1). Edited by Allen Kent and Harold Lancour. (Marcel Dekker, Inc., 95, Madison Avenue, New York, U.S.A.), 1968. Pp. xii + 676. Price $ 45.00 per volume (non-subscription); $ 35.00 per volume (subscription).

The problems of organizing knowledge for ready availability have been a matter of serious concern for centuries. The library traditionally has had the function of acquiring, organizing, storing, and disseminating previously generated information, representing the foundation of society's knowledge. As the growing volume of recorded information began to strain the traditional library science tools, a divergent strain of documentation and information science developed, with its own set of tools and techniques. Unfortunately, the latter field overlapped library science only superficially, even though the two areas emerge from a common problem.

This 18-volume Encyclopedia, an authoritative work on library science and information science, combines both theory and practice of the two fields in the United States and abroad. It is arranged in one straight alphabet, as is a dictionary There are cross-references from one heading to another. The final volume will contain a detailed analytical index to the entire work which is to be used as the principal means of getting into the body of the text. Where appropriate, at the end of the article will be found references to other articles for additional information on the same general topic.

In a work such as this there are many references to individuals both living and deceased. Biographies of many prominent figures in the fields within the scope of the Encyclopedia are included in the regular alphabet. Such biographies are for deceased individuals only.

The chapters dealt with in Volume 1 are: Abbreviations; Abstract Classification; Abstracts and Abstracting; Academic Status of Librarians and Information Scientists; Access Time; Accessioning; Accountability; Accreditation of Library Education; Acquisitions; Adaptive Systems; Administration; Adult Education; Advertising and Marketing Division, SLA; Aeronautic and Aerospace Libraries; Aerospace Division, SLA; Afghanistan, Libraries In; Africa, Libraries In; Afro-Scandinavian Library Conferences; Agricultural Libraries and Collections; Air Force Libraries; Airlie House Conferences; Alabama Library Association; Alaska State Library Association; Albania, Libraries In; Albany, State University of New York at Albany, School of Library Science; Aldus Manutius, Venice; Alexandrian Library; Algebra of Classes; Algeria, Libraries In; Algorithms; Allerton Park Institutes; All-Union Book Chamber; All-Union Institute of Scientific and Technical Information; Alphabetic Indexes; Alphabets; Ambiguity; American Antiquarian Society; American Association of Law Libraries; American Book Publishers Council; American Chemical Society Information Program; American Library Association; American Society of Metals; Analog Devices; Analysis of Information; Analysis of Variance; Analytics; Ancient and Medieval Libraries; Anglo-American Code; Anglo-Scandinavian Library Conferences; Annotations; Annuals; Anonymous and Pseudonymous Works; Anthology and Anthologists; Antiquarian Booksellers Association of America, Inc.; Aperture Card; Architectural Libraries and Collections; Architectural Literature; Architecture, Library Building; Archives; Archons of Colophon; Argentina, Libraries In; Aristotelian Logic; Arizona State Library Association; Armed Forces Libraries; Array Processing; Art Libraries and Collections; Art Literature; Artificial Classification; Artificial Intelligence; Artificial Languages; Artificial Questions; Ashendene Press; Asia, Libraries In; Aspect Systems; Assam Library Association; and Associacao Brasileira De Escolas De Biblioteconomia E Documentacao.

This Encyclopedia is of value to librarians, information scientists, computer scientists, advanced students, and researchers in related fields.

C. V. R.

Purification of Inorganic and Organic Materials—*Techniques of Fractional Solidification.* Edited by Morris Zief. (Marcel Dekker, Inc., New York), 1969. Pp. xvii + 318.

In recent years chemists and physicists have centered their attention on the investigation of pure or ultrapure research materials, organic as well as inorganic. In the search for high purity three problems are interrelated—preparation, characterization, and containment. Along with the accelerated development of sophisticated methods in the area of trace analysis, the isolation of ultrapure materials has multiplied at a phenomenal rate. One of the most important preparative techniques is fractional solidification. *Fractional Solidification* (edited by M. Zief and W. Wilcox) brought together the basic principles, apparatus, and applications of all types of fractional solidification processes. This book under review brings together reliable processes for the preparation of pure materials worked out by experienced investigators.

The contributors also explore the most important methods for characterizing and storing pure organic and inorganic chemicals. The realization that techniques such as zone melting, progressive freezing, and column crystallization are now available for the production of chemicals has captured the imagination of the chemical industry. Among the topics covered are purification of indium antimonide, zone melting of metal chelate systems, reduction of cyclohexane content of benzene by column crystallization, purification of potassium chloride by radio-frequency heating, continuous zone refining of benzoic acid, zone-melting chromatography of organic mixtures, and analysis of ultrapure materials. The methods have been chosen for originality and adaptability to the problems encountered in the laboratory. The power and flexibility of fractional solidification is made apparent. This book is valuable to the chemist, chemical engineer, and metallurgist, serving the needs of both the researcher and the engineer.

C. V. R.

Electroanalytical Chemistry (Vol. 3). Edited by Allen J. Bard. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1969. Pp. xii + 311. Price $ 15.75.

This series is designed to provide authoritative reviews in the field of modern electroanalytical chemistry defined in its broadest sense, with reviews of recent developments and applications of well-established techniques. It also includes discussions of the background and problems in areas still being investigated extensively and of techniques generally outside the scope of electroanalytical chemistry which can be applied fruitfully to electrochemical problems.

Electroanalytical chemists and others are concerned not only with the application of new and classical techniques to analytical problems, but also with the fundamental theoretical principles upon which these techniques are based. Electroanalytical techniques are proving useful in such diverse fields as electro-organic synthesis, fuel cell studies, and radical ion formation, as well as with such problems as the kinetics and mechanism of electrode reactions and the effects of electrode surface phenomena, adsorption, and the electrical double layer on electrode reactions.

This series is of use to the specialist and non-specialist alike—it provides a background and a starting-point for graduate students undertaking research in these areas, and is of value to practising analytical chemists interested in learning about and applying electroanalytical techniques.

Volume 3 of the series contains the following articles: Application of Controlled-Current Coulometry to Reaction Kinetics, by Jiri Janata and Harry B. Mark, Jr.; Non-aqueous Solvents for Electrochemical Use, by Charles K. Mann; Use of the Radioactive-Tracer Method for the Investigation of the Electric Double-Layer Structure, by N. A. Balashova and V. E. Kazarinov; and Digital Simulation: A General Method for Solving Electrochemical Diffusion-Kinetic Problems, by Stephen W. Feldberg.

C. V. R.

Annual Review of Pharmacology (Vol. 9). Edited by H. W. Elliott. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1969. Pp. vii + 591. Price: U.S.A. $ 8.50, Foreign $ 9.00.

Volume 9 of this well-known series contains the following articles: Essential Pharmacology; Drugs and Enzyme Induction; Chemotherapy of Leprosy; Cancer Chemotherapy; Micropuncture and Diuretics; Action of Drugs on Movement of Ocular Fluids; Physiological and Pharmacological Aspects of the Platelet; Adrenergic Mechanisms; Ganglionic Transmission; Drugs Affecting Smooth Muscle; Pharmacology of Motor Nerve Terminals; Central Synaptic Transmission—Microelectrophoretic Studies; EEG and Human Psychopharmacology; Mechanisms of General Anesthesia by Non-Hydrogen-Bonding Molecules; The Peripheral Effects of Anesthetics; Behavioural Pharmacology and Toxicology; Calcitonin and Parathyroid Hormone; Drugs and Uric Acid; Effects of Oral Contraceptives; Toxicology of Ethanol; Use of Cell Culture in Pharmacology; Isolation Techniques for Pharmacologically Active Substances (Animal); New Substances of Plant Origin which Increase Non-specific Resistance; *In Vivo* Therapy of Oncogenic Viruses; Allergy and Drug Sensitivity of Skin; Self-Administration of and Behavioural Dependence on Drugs; Duration of Local Anesthesia; and Review of Reviews. C. V. R.

Technological Forecasting—*An International Journal.* (American Elsevier Publishing Company, Inc., 52, Vanderbilt Avenue, New York, N.Y. 10017), 1969. Subscription Price: Vol. 1 (4 issues) $ 22.00 + $ 2.00 postage.

This new journal is intended for publication of articles which deal directly with the methodology and practice of technological forecasting as a planning tool, including the interrelationship of social, environmental, and physical factors affecting such forecasts.

The following contents of the first issue, Vol. 1, No. 1, June 1969, will give an idea of the scope of the journal: (1) Normative Technological Forecasting; (2) Aviation's Role in Future Transportation; (3) Action and Reaction; (4) SEER: A Delphic Approach Applied to Information Processing; (5) When is a Need a Need? The Problem of Normative Forecasting in a Changing Environment; (6) Technological Forecasting and the Autonomy of Technology; (7) The Organization of Technological Forecasting in the Soviet Union; (8) Planning of Production and Consumption in the U.S.S.R. (9) The Process of Making Forecasts; and (10) A Methodological Approach to the Integration of Technological and Social Forecasts. A. S. G.

Physics. By R. Resnick and D. Halliday. Part I. *Mechanics, Wave Motion and Heat*; Part II. *Electromagnetism, Optics and Quantum Physics.* (Wiley Eastern Private Ltd., J 41, South Extension 1, New Delhi-3). Part I: Pp. 646 + 63; Part II: Pp. 647–1214 + 8. Price Rs. 13·50 each part.

This publication in two volumes will be a suitable text-book in Physics for undergraduate students. Part I on Mechanics, Wave Motion and Heat contains 25 chapters which include Vectors, Linear Kinematics, Particle Dynamics, Conservation of Energy and Momentum, Rotational Kinematics and Rotational Dynamics, Gravitation, Fluid Dynamics, Wave Motion, Sound, Thermodynamics, Kinetic Theory, etc.

Part II on Electromagnetism, Optics and Quantum Physics contains 23 chapters which include Charge and Matter, Electric Field, Gauss's Law, Magnetic Properties of Matter, Electromagnetic Oscillations, Electromagnetic Waves, Nature and Propagation of Light, Spectra, Polarisation, Light and Quantum Physics, Waves and Particles.

It will be noticed that the selection of topics is in a traditional way. But the treatment is more unified than in ordinary text-books, and emphasis has been given to the relation between classical and modern theories. The fundamental principles are dealt at a mathematical level that assumes a concurrent course on elementary calculus. A. S. G.

Fundamental Chemistry (Second Edition). By D. H. Andrews and R. J. Kokes. (First published by Wiley Eastern; Reprint by Wiley Eastern Private Ltd., J 41, South Extension 1, New Delhi-3). Pp. 811. Price Rs. 13·50.

This highly popular text-book on fundamental chemistry is now made available as a low-price edition so as to be within reach of all students of physics and chemistry undergoing degree courses in Indian Universities. It is needless to point out that the book provides an excellent introduction to modern chemistry. The treatment is clear and systematic, and there are numerous worked-out examples in the text and problems at the end of each chapter. The block figures and diagrams are highly instructive. A. S. G.

Books Received

Farmers of India (Vol. IV)—*Madhya Pradesh, Rajasthan, Gujarat, Maharashtra.* (Indian Council of Agricultural Research, Krishi Bhavan, New Delhi), 1969. Pp. xv + 317. Price Rs. 28·00.

Remote Sensing of Environment (Vol. I, No. 1), March 1969. (American Elsevier Publishing Co., Inc., 52, Venderbilt Avenue, New York 10017), 1969. Pp. vii + 80. Subscription: Vol. I. $ 28.00 *plus* postage $ 2.00; Single copy including postage $ 7.50.

Purification of Inorganic and Organic Materials—Techniques of Fractional Solidification. Edited by Morris Zief. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1969. Pp. xvii + 318. Price not given.

Physical Metallurgy of Iron and Steel. By Rajendra Kumar. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1968. Pp. xvi + 456. Price Rs. 35·00.

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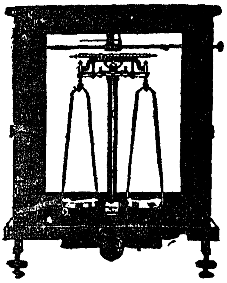

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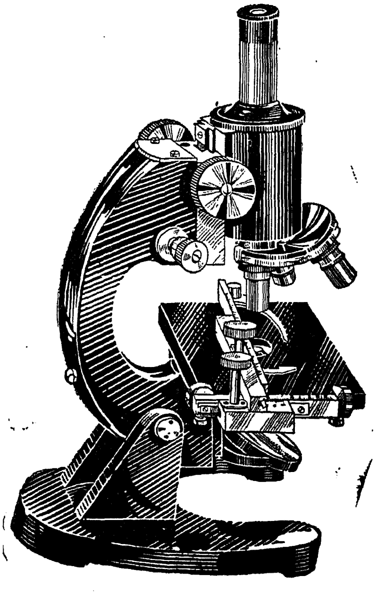

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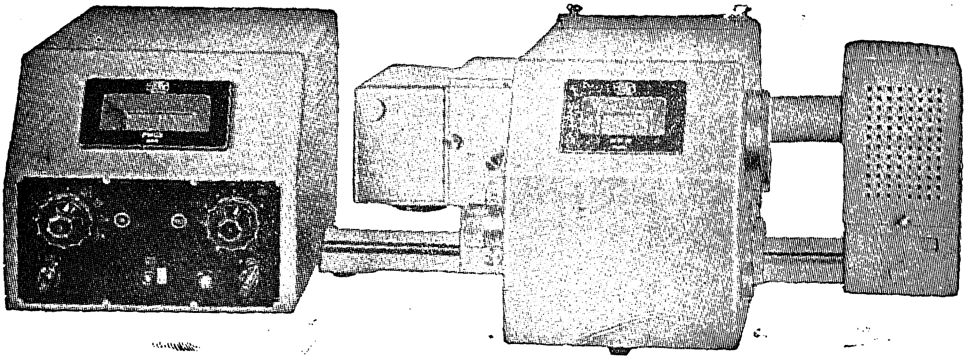

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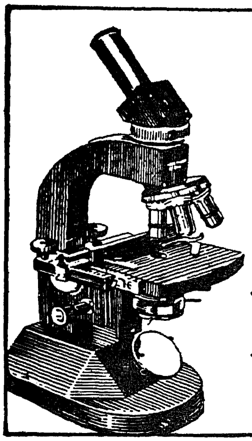

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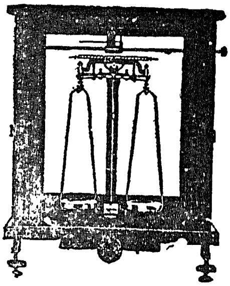

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THE FLORACHROMES: THEIR CONSTITUTION AND OPTICAL BEHAVIOUR

SIR C. V. RAMAN

1. INTRODUCTION

THE nature of the pigments or colouring matters which are present in the petals of flowers and which are responsible for the hues which they exhibit is a subject of great interest. An important first step towards the determination of their nature makes use of a very simple procedure, which is to view the flowers held in bright sunlight through a pocket spectroscope. The spectrum of the light emerging through the petals or diffusely reflected by them when thus examined exhibits characteristic features. Certain regions in the spectrum are observed to be much weakened or even totally extinguished, while other regions do not exhibit any noticeable diminution in their intensity. The spectral regions which exhibit the absorption are indicative of the nature of the floral pigments, while those regions of the spectrum which escape such absorption and are present in the emergent diffused light determine the observed colour of the petals.

Another procedure for the study of the floral pigments which suggests itself is their extraction from the petals with the aid of suitable solvents and the spectroscopic examination of the solutions thus obtained. In following this procedure, it is obviously of the highest importance that the solvent employed does not produce any noticeable change in the constitution or optical behaviour of the pigment. Whether such a change is actually produced becomes evident on a comparison of the colour of the petals and their spectroscopic behaviour *in vivo* with the colour and spectroscopic behaviour of the solution of the extracted material. In most cases, the pigments are so firmly embedded in the structure of the petals that an attempt to extract them by placing them in a vessel containing water or methyl alcohol or ethyl alcohol, followed by vigorous shaking produces no observable result. Much more successful is the use of acetone as a solvent. In numerous cases, immersion of the petals in acetone and vigorous shaking results in a nearly complete extraction of the colouring matter. Other cases which resist such simple treatment may be successfully dealt by first grinding the petals in an agate mortar and adding a little acetone to the pulp thus obtained. Filtering the acetone extract yields a clear solution which can then be spectroscopically examined.

There are several advantages in thus studying the floral extracts instead of the flowers themselves *in vivo*. By regulating the quantity of the petals used for the extraction and the volume of the solvent employed, the concentration of the solution can be adjusted to that best adapted for spectroscopic examination. The length of the absorbing column and the intensity of the light-beam can also be chosen suitably. Further, it is only by using the extracted material in solution that it is possible to obtain spectrophotometric records of the transmitted light with the instruments generally available. Still another advantage is that the extraction can be carried out in successive steps, thereby enabling it to reveal whether we are concerned only with one pigment or with more pigments than one differing in their solubility in various liquids.

2. THE FLORACHROMES

Studies by the author adopting the techniques described above resulted in the discovery that there are two distinct categories or species of floral pigment characterised by quite different spectroscopic behaviours. In the publication announcing this discovery, the author ventured to name these categories as Florachrome A and Florachrome B respectively. The presence of one or of the other pigment, in greater or less quantity, is found to be responsible for the observed floral colours in numerous cases. The simultaneous presence of the two categories of pigment in diverse proportions is also found to be the explanation of many other floral colours met with in practice.

The ease with which the spectral behaviour of individual flowers *in vivo* can be recognised would naturally depend on the particular circumstances of the case and especially on the quantity of the pigment present in the petals. It is evident that either too little or too much of the pigment would be unfavourable for a direct observation of the absorption spectrum in the light emerging from or diffused by the petals. It is therefore useful to mention some cases in which the characteristics of the florachromes are exhibited with the maximum clarity by the flowers themselves.

The example chosen for special mention here is *Clitoria ternata*, which bears flowers of some size. In one variety, these exhibit wide margins of a bright blue colour. The plant belongs to the botanical class *Leguminosæ* and is a hardy perennial by nature, though it may be raised and grown as an annual from seeds. Commonly known as the Butterfly-Pea, it is to be found in many Indian gardens. Viewed through a spectroscope in bright light, the blue areas exhibit a characteristic three-banded spectrum, the most striking feature of which is an intense absorption at about 630 mμ, followed by another distinctly less intense absorption at about 575 mμ, and a very weak and diffuse band at about 530 mμ. As the result of the first two absorptions, the entire spectrum between 630 mμ and 575 mμ is seen with much reduced intensity. It is thus evident that the observed bright blue colour of the flower is a consequence of the reduced intensity of the orange and the yellow regions in the spectrum of the light diffused by its petals. The pigment responsible for the observed blue colour of *Clitoria ternata* is readily extracted by simple immersion of its petals in acetone. A tube five centimetres long containing the blue extract shows the same features in its spectrum as the petals themselves, but more conspicuously.

A particularly fine example of the absorption spectrum of Florachrome B exhibited with the maximum of clarity is furnished by the terrestrial or ground orchid known botanically as *Spathoglottis plicta.* This is a very hardy plant which may be grown in pots like any other garden plant. It flowers profusely at all seasons of the year, bearing racemes of flowers on erect spikes of great length. The material is therefore available in quantity for examination at all times. The petals exhibit a purplish-red colour, and the spectrum exhibits a three-banded structure but this differs from that Florachrome A. The most intense of the three absorption bands is located around 590 mμ and completely obscures the yellow region in the spectrum. A second band of distinctly lesser intensity is located in the green around 540 mμ. A third band which is rather faint appears in the blue-green region of the spectrum around 510 mμ. The region of still smaller wavelengths exhibits no noticeable absorption. It is evident that the extinction of the yellow and the weakening of the green regions in the spectrum are responsible for the observed colour of the flower.

The floral pigment is readily extracted from the petals of the orchid *Spathoglottis plicta* by immersing them in a beaker containing acetone. The extract exhibits a purplish-red colour and the spectrum of the light transmitted by it exhibits features similar to those of the flowers *in vivo.* But there is an observable change in the relative intensities of the bands. The band in the green appears somewhat more intense than the band in the yellow as seen in the spectrum of the acetone extract.

Spectrophotometric records of the absorption spectra of the acetone extracts from *Clitoria ternata* and from *Spathoglottis plicta* are reproduced respectively as Fig. 1 and Fig. 2. The wavelengths shown were roughly estimated from their positions on the recorded chart, and lay no claim to precision. But the reproduced curves should be sufficient to convince any one that two florachromes actually exist exhibiting different spectrophotometric behaviours.

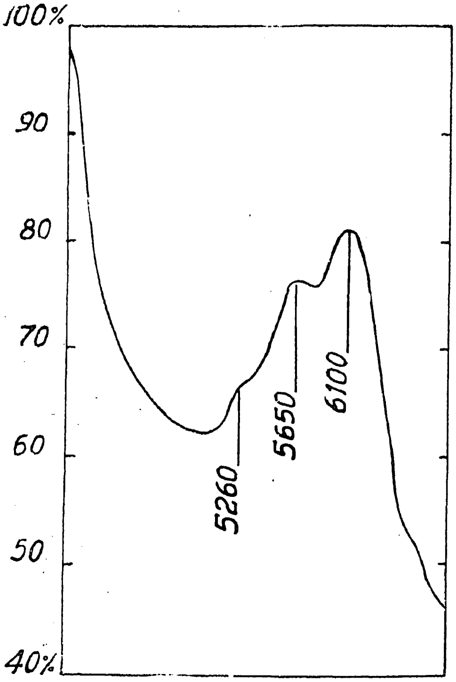

Fig. 1. Absorption Spectrum of *Clitoria ternata.*

As an example of a flower of which the observed colour is due to the co-existence of both the florachromes, we may cite the case of the blue iris (*Iris germonica*). The curiously shaped flowers of this plant have petals of a purplish-blue colour. But this is not a deep or saturated colour, and it is therefore not surprising that spectroscopic examination of the light diffused by the petals shows only weak and ill-defined bands. Examination of the light transmitted through two petals held together however exhibits the bands more distinctly. In particular, the absorption band in the yellow region can be seen, and the presence of an absorption band in the red region is also evident. Immersion of the petals of the blue iris in acetone results in the immediate extraction of a solution which exhibits a purplish-red colour, which the spectroscope reveals as due for the most part to the presence of Florachrome B. The residue left after the acetone extraction when stirred in water yields a blue solution which the spectroscope reveals as due to the presence of Florachrome A. Similar results have been obtained with many other flowers. In these cases, the acetone extract from the petals either in the natural state or after being ground to a pulp in an agate mortar is a purplish-red solution exhibiting the absorption spectrum of Florachrome B, while the residue when stirred up with water gives a blue solution showing the absorption spectrum of Florachrome A.

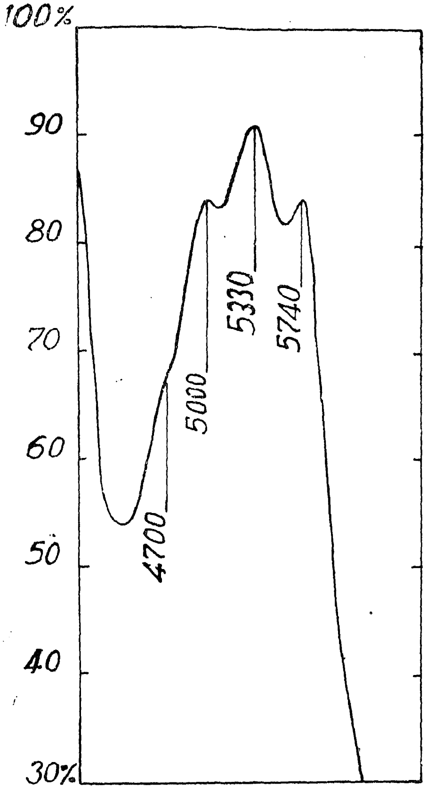

FIG. 2. Absorption Spectrum of *Spathoglottis plicta*.

We now proceed to consider the explanation of the spectra of the two florachromes in terms of their chemical constitution. Though the spectra are quite different, they exhibit a measure of similarity which indicates that they are substances of the same general nature which differ only in the specific configuration of the centres responsible for the absorption of the light by the molecules of the pigment. The triplet band observed in both the cases is readily interpreted as due to the electronic absorption by a CO group in the structure giving the most intense line of the triplet, while its two other weaker and more diffuse companions represent its combinations with vibrational transitions. The three possible structures of a molecule of the pigment are represented as (*a*), (*b*) and (*c*) respectively in Fig. 3. If (*a*) and (*b*) are superposed on each other, we have an absorbing centre where the CO group remains in the same position throughout. On the other hand, if (*b*) and (*c*) are superposed, the CO occupies two positions alternately. The electronic energy of the CO group would obviously be different in the two cases. We may identify the superposition of (*a*) and (*b*) as giving us Florachrome A, and the superposition of (*b*) and (*c*) as giving Florachrome B, which has the higher electronic energy.

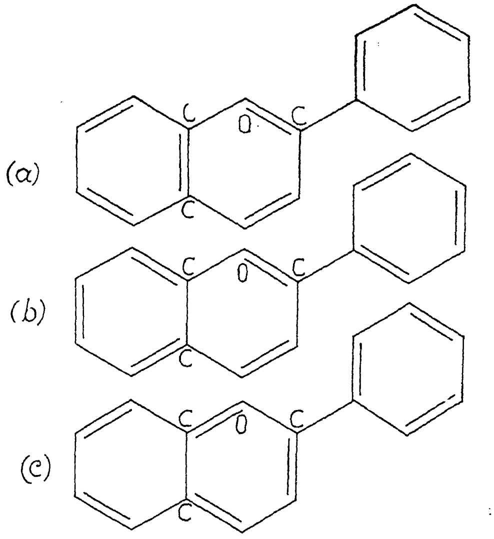

FIG. 3. Chemical Constitution of the Florachromes.

The spectrophotometric records reproduced as Fig. 1 and Fig. 2 were made in the Instruments Section of the Indian Institute of Science to whose authorities the thanks of the author are due.

CONVERSION OF PLAGIOCLASE TO NEPHELINE

T. R. NARAYANAN KUTTY, G. V. ANANTHA IYER AND A. R. VASUDEVA MURTHY
Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore-12, India

THIS communication reports the conversion of anorthite rich plagioclase to nepheline by the cation exchange reaction with sodium chloride. Two different conditions are employed: (*i*) reaction in the solid-state (around 750° C.) (Duffin, 1964), (*ii*) reaction in molten sodium chloride (at 900° C.). In molten sodium chloride, the oligoclase is found converted to a mixture of albite and nepheline.

METHOD

In one case the powdered mixture (200 mesh) sodium chloride (2·5 g) is mixed with the plagioclase (0·1 g) and maintained at 750° C. in a platinum crucible for 48 hours. In the other case, the mixture is heated to 900° C. and is maintained molten for 4 to 8 hours. After the interval, the cooled material is washed with water on a sintered glass septum, till free of chloride. The solid remaining undissolved is found to be nepheline and utilised for further investigation. Calcium is detected in the washings and is estimated by EDTA titrations using calcein as indicator.

ANALYSIS

The plagioclase feldspar used in this investigation is a phenocryst from the dolerite dyke of Nandydurg Mine of Kolar Gold Fields. The oligoclase used is from the acid charnockite of Halagur (Bangalore District).

The composition of the anorthite rich plagioclase is as follows:

$Na_2O = 3·55\%$, $CaO = 13·65\%$, $K_2O = 0·22\%$, $Al_2O_3 = 31·05\%$, $SiO_2 = 51·3\%$, corresponding to that of 67% anorthite. The oligoclase has the composition $Na_2O = 6·15\%$, $CaO = 4·9\%$, $K_2O = 0·35\%$, $Al_2O_3 = 25·52\%$, $SiO_2 = 59·92\%$ (30% anorthite). The product obtained from the ion exchange reaction of anorthite has the composition: $Na_2O = 18·65\%$, $Al_2O_3 = 30·71\%$, $SiO_2 = 50·51\%$. The calcium and potassium content of nepheline obtained from the reaction in molten sodium chloride is below detection. The estimated lime content in the washed solution is 13·6% of the original sample. This indicates that nearly complete substitution of calcium occurs when the exchange is carried out with oligoclase.

INFRARED SPECTRUM

The I.R. spectrum is made use of to identify the different phases. The spectra of 67-anorthite (I), the converted material (II), and that of a natural sample of nepheline (III) are presented in Fig. 1. The spectrum of nepheline obtained from the solid-state reaction is identical with that of the natural sample. It is also clear from the spectrum that the nepheline obtained by the reaction is free of unconverted feldspar.

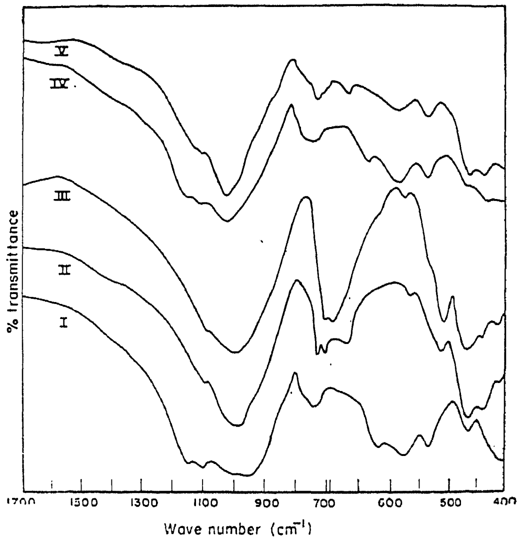

FIG. 1. Infrared spectrum. I, 67% anorthite; II, Converted sample; III, Nepheline (from Rajasthan); IV, 30% anorthite; V, Converted sample from 30% anorthite.

The spectrum IV is of the oligoclase while V is that of the same material heated in molten sodium chloride. Spectrum V indicates that the product is a mixture of albite and nepheline.

DISCUSSION

The conversion of anorthite to nepheline takes place by the cation exchange reaction as:

$$CaAl_2Si_2O_8 + 2NaCl = 2NaAlSiO_4 + CaCl_2.$$

It follows that the cation exchange is accompanied by the rearrangement of the silicate framework. In many reactions of aluminosilicates, it is envisaged that the substitution of Ca^{+2} or Na^{+} occurs along with the addition or removal of Al^{+3} or Si^{+4} from the silicate framework. From the present set of experiments, it is evident that during the exchange of cations of unequal charges, the rearrangement of the silicate structure occurs in preference to the substitution or depletion of Al^{+3} or Si^{+4}. This is much more important in the case of 67% anorthite for which the reaction can be represented as:

$$NaCa_2Al_5Si_7O_{24} + 4NaCl = Na_5Al_5Si_7O_{24} + 2CaCl_2 \quad (NaAlSi_3O_8 : 2CaAl_2Si_2O_8).$$

This results in a nepheline with Si : Al ratio of 1·4 with a lower sodium content. It is known that the natural samples of nepheline contain excess of Si over the theoretical amount and the variation in Si : Al ratio varies up to 1·4 (B. Mason, 1966). Therefore, such cation exchange reactions may be occurring in nature as well, resulting in nepheline of higher silica content.

The resemblance of the infrared spectrum of the natural sample of nepheline and that from the solid-state reaction is very striking. This clearly indicates the formation of nepheline by such solid-state reactions in nature. The natural samples of nepheline contain more of K^{+} and Ca^{+2} as impurity. The difference in the spectrum II and III (650–750 cm.$^{-1}$ and 400–450 cm.$^{-1}$ region) is due to the presence of these ions. On the other hand, nepheline obtained from the molten sodium chloride is completely devoid of K^{+} and Ca^{+} ions. Therefore, the I.R. absorption bands are clearly split. The same situation exists in the I.R. spectrum of albite and microcline (Lyons, 1967).

It may be expected that by heating plagioclase in molten potassium chloride gives rise to kaliophillite. But, it is observed that cation exchange takes place only to a certain extent (2·0% K_2O is taken by 67-anorthite, in molten KCl). This can be atributed to the difference in size of Ca^{+2} and K^{+}. In the case of sodium chloride melt, initially complete substitution of Ca^{+2} by Na^{+} in plagioclase takes place readily. Consequently, the silicate framework rearranges to accommodate another ion of Na^{+}. The initial substitution of K^{+} can be expected to be very slow. On the other hand, kaliophillite may be formed by heating celsian in molten KCl. Due to the non-availability of clesian, this has not been attempted.

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3. Mason, B., *Principles of Geochemistry*, John Wiley and Sons, Inc., N.Y., 1966.

A NOTE ON AN INVARIANT OF SPHERICALLY SYMMETRIC SPACE-TIMES

A. R. PRASANNA
University of Poona, Poona-7

IN our recent investigations of spherically symmetric metrics, we have found that for the most general spherically symmetric metric

$$ds^2 = -A dr^2 - B d\Omega^2 + C dt^2 + 2D dr dt,$$
$$d\Omega^2 = d\theta^2 + \sin^2\theta \, d\phi^2, \tag{1}$$

where A, B, C, D are functions of r and t alone, the quantity

$$I = \frac{f_1 f_4 - f_5^2}{f_2 f_3} \tag{2}$$

is an invariant under arbitrary non-singular transformations $(r, t) \rightarrow (\bar{r}, \bar{t})$ preserving spherical symmetry. Here f_1, f_2, f_3, f_4 and f_5 are the independent non-vanishing components of the curvature tensor R_{hijk} in the notations of Takeno[1] as given by

$$f_1 = R_{1212} = \frac{R_{1313}}{\sin^2\theta}, \quad f_2 = R_{1414}. \quad f_3 = \frac{R_{2323}}{\sin^2\theta},$$
$$f_4 = R_{2424} = \frac{R_{3434}}{\sin^2\theta}, \quad f_5 = R_{1224} = \frac{R_{1334}}{\sin^2\theta}. \tag{3}$$

Since the variation of the gravitational field from point to point is mainly brought out by the curvature tensor, this invariant I is of interest. As we have found, this also seems to have a good geometrical interest.

Firstly, we have found that for all the solutions of the field equations

$$R_{ij} = 0 \tag{4}$$

with spherical symmetry, this invariant I has the value $\frac{1}{4}$. This covers the case of Schwarzschild's external metric. Further, we find that for all the spherically symmetric metrics of constant curvature which satisfy the relation

$$R_{hijk} = K_0 \left(g_{hj} g_{ik} - g_{ij} g_{hk}\right) \tag{5}$$

where K_0 is a constant, the invariant I has the value unity.

A necessary and sufficient condition for the space-time

$$ds^2 = -A dr^2 - r^2 d\Omega^2 + C dt^2 \tag{6}$$

to be of class one, as obtained by Takeno,[2] can be expressed as

$$f_3 \neq 0, \quad f_2 f_3 = f_1 f_4 - f_5^2 \tag{7}$$

which when $f_2 \neq 0$ means $I = 1$. This is in conformity with the well-known result that every space of constant positive curvature is of class one.

In order to understand the significance of I, we have evaluated it for some well-known general relativistic metrics.

1. The Nordström metric:

$$ds^2 = -\left(1 - \frac{2m}{r} + \frac{4\pi e^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2 + \left(1 - \frac{2m}{r} + \frac{4\pi e^2}{r^2}\right) dt^2,$$

$$I = \frac{\frac{1}{4}\left(m - \frac{4\pi e^2}{r}\right)^2}{\left(m - \frac{2\pi e^2}{r}\right)\left(m - \frac{6\pi e^2}{r}\right)}. \tag{8}$$

2. The Schwarzschild-deSitter metric:

$$ds^2 = -\left(1 - \frac{2m}{r} - \frac{\Lambda r^2}{3}\right)^{-1} dr^2 - r^2 d\Omega^2 + \left(1 - \frac{2m}{r} - \frac{\Lambda r^2}{3}\right) dt^2,$$

$$I = \frac{\left(\frac{\Lambda}{3} - \frac{m}{r^2}\right)^2}{\left(\frac{\Lambda}{3} + \frac{2m}{r^3}\right)^2}. \tag{9}$$

3. Vaidya's metric[3] for a radiating star:

$$ds^2 = -\left(1 - \frac{2m}{r}\right)^{-1} dr^2 - r^2 d\Omega^2 + \frac{\dot{m}^2}{f^2}\left(1 - \frac{2m}{r}\right) dt^2,$$

where

$$m = m(r, t), \quad f = m'\left(1 - \frac{2m}{r}\right),$$

$$I = \tfrac{1}{4}. \tag{10}$$

Although here $R_{ij} \neq 0$, the conditions prescribed on T_{ij} are such as to lead to $I = \frac{1}{4}$, even for

$$ds^2 = -A dr^2 - B d\Omega^2 + C dt^2.$$

4. The Schwarzschild internal metric:

$$ds^2 = -\left(1 - \frac{r^2}{R^2}\right)^{-1} dr^2 - r^2 d\Omega^2 + \left(A - B\sqrt{1 - \frac{r^2}{R^2}}\right)^2 dt^2, \tag{11}$$

$$I = 1.$$

5. The Robertson-Walker metric:

$$ds^2 = \frac{-R^2(t)}{\left(1 + \frac{kr^2}{4}\right)^2}\left(dr^2 + r^2 d\Omega^2\right) + dt^2,$$

$$I = 1. \tag{12}$$

6. The Hoyle-Narlikar[4] metric:

$$ds^2 = -\left(1 - \frac{p}{r}\right)^{-2} dr^2 - r^2 d\Omega^2 + \left(1 - \frac{p}{r}\right)^2 dt^2$$

where $\mu = m_0 p/(r - p)$, $2\pi m_0 p - 1$, m_0 and p being constants,

$$I = \frac{m_0^2}{(4 m_0^2 - \mu^2)}. \tag{13}$$

Thus the value of the invariant is finite for almost all the well-known spherically symmetric metrics. However, we may note here that it is possible at least in principle to construct metrics with one or more of f_1, f_2, f_3, f_4 and f_5 being zero. In such cases the invariant is either zero, infinite or indeterminate.

ACKNOWLEDGEMENTS

I wish to thank Professor V. V. Narlikar for suggesting me this investigation and for his valuable guidance in preparing this note. I also wish to thank the U.G.C. for awarding me a research scholarship.

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[1] Takenon, H., 'The theory of spherically symmetric space-times" (Revised edition), *Scientific Report No. 5*. 1966, p. 13.

[2] —, *Ibid.*, p. 200.

[3] Vaidya, P. C., *Proc. Ind. Acad. Sci.*, 1951, **33 A**, 264.

[4] Hoyle, F. and Narlikar, J. V., *Proc. Roy. Soc.*, 1966, **294 A**, 142.

LETTERS TO THE EDITOR

RAMAN AND INFRARED SPECTRA OF N, N-DIMETHYLBUTYRAMIDE AND INTEGRATED ABSORPTION INTENSITIES OF THE CARBONYL BAND OF SOME AMIDES

THE integrated absorption intensities of carbonyl band of some amides have been measured by Venkata Chalapathi, Venkata Ramiah and Syamala Krishna Sayee[1,2] and the vibrational frequencies of some tertiary amides —Dimethylformamide and Dimethylacetamide— have been assigned on the basis of band contour studies and normal vibrational analysis.[3,4] We now report the Raman and infrared frequencies of N, N-dimethylbutyramide and also the integrated absorption intensities of the carbonyl band of some amides of the butyramide series.

The Raman spectrum of N, N-dimethylbutyramide has been recorded with Hilger Raman source unit and Fuess glass spectrograph using λ 4358 as the exciting radiation. The infrared spectrum of the same amide was recorded with Perkin Elmer Model 331 spectrophotometer using a micro-film of the liquid between NaCl and KBr plates. The Raman and infrared frequencies with their assignments are given in Table I.

TABLE I

Vibrational frequencies (in cm.$^{-1}$) of N, N-dimethylbutyramide

Raman	Infrared	Assignment
2945 (7)	2960 (s)	ν_{as} (CH_3) N
2935 (9)	2930 (m)	ν_s (CH_3) N
..	2890 (sh)	ν_{as} (CH_3) C
2865 (9)	2870 (m)	ν_s (CH_3) C
1640 (7)	1640 (vs)	ν $(C{=}O)$
1446 (8)	1480 (m)	ν $(C{-}N)$
..	1450 (m)	δ_{as} (CH_3) C N
1405 (8)	1380 (s)	δ_s (CH_3) N
..	13 0 (w)	δ_s (CH_3) C
1272 (5)	1250 (m)	$\nu_{as}\left(N\genfrac{}{}{0pt}{}{CH_3}{CH_3}\right)$
1155 (5)	1145 (s)	ω (CH_3) N
..	1085 (m)	ω (CH_3) C
1050 (4)	1065 (m)	γ (CH_3) N
1030 (4)	1010 (w)	γ (CH_3) C
961 (2)	960 (w)	ω (CH_2) C
..	945 (w)	ω (CH_2) C
901 (4)	895 (w)	ν $(C{-}CH_3)$
868 (4)	870 (sh)	ν $(C{-}CH_2)$
820 (3)	810 (w)	ν $(C{-}CH_2)$
798 (5)	790 (vw)	γ (CH_2) C
..	750 (w)	γ (CH_2) C
729 (6)	720 (w)	$\nu_s\left(N\genfrac{}{}{0pt}{}{CH_3}{CH_3}\right)$
597 (0)	595 (w)	δ $(O{=}C{-}N)$
480 (2)	470 (w)	$\delta_{as}\left(N\genfrac{}{}{0pt}{}{CH_3}{CH_3}\right)$
413 (2)	..	γ $(C{-}CH_3)$
330 (3)	..	$\delta_s\left(N\genfrac{}{}{0pt}{}{CH_3}{CH_3}\right)$
242 (0)	..	γ $(C{-}CH_2)$

These assignments are made on the basis of assignments of vibrational frequencies of related molecules.[3,4]

The infrared spectra of the carbonyl band of butyramide, butyranilide and dimethylbutyramide have been recorded in solution of $CHCl_3$ with Perkin Elmer Model 221 infrared spectrophotometer using matched cells of 1 mm. thickness with NaCl windows. The integrated intensities of the carbonyl band as calculated by Wilson-Well's method are given in Table II.

TABLE II

Amide	Frequency	Molar concentration	$B = 2\cdot303\int \epsilon d\nu$	Wing correction	Integrated intensity (A moles^{-1} litre cm.$^{-2}\times 10^4$)	Average value of A
Butyramide	1682	0·010	4·65	0·67	5·3	5·3
		0·008	4·53	0·64	5·2	
		0·006	4·64	0·65	5·3	
		0·005	4·63	0·64	5·3	
Butyranilide	1690	0·010	3·70	0·65	4·4	4·5
		0·008	3·86	0·64	4·5	
		0·006	3·80	0·57	4·4	
		0·005	3·87	0·60	4·5	
Dimethylbutyramide	1633	0·010	4·72	0·70	5·4	5·6
		0·008	4·89	0·72	5·6	
		0·006	4·73	0·75	5·5	
		0·005	4·93	0·78	5·7	

The integrated intensities of the carbonyl band of the amides are higher than those of aldehydes, ketones and esters[5-7] and this is due to the fact that in amides, two possible structures contribute to the resonance hybrid with the dipolar resonance structure making substantial contribution to the ground state. The integrated intensity of the carbonyl band of butyranilide has a lower value and this is due to reduction in the polarity of the C=O bond as a result of delocalisation of lone pair of electrons of nitrogen atom over the aromatic nucleus of the anilide.

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Post-Graduate Centre, K. VENKATA RAMIAH.
Osmania University,
Warangal-1,
and
Dept. of Physics, P. SYAMALA KRISHNA SAYEE.
Osmania Univ.,
Hyderabad-7, *July* 14, 1969.

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A DOUBLE OXALATE OF IRON (II) AND ZIRCONIUM (IV)

PREPARATION of a double oxalate of Iron(II) and titanium (IV) has been reported earlier.[1] In this paper the preparation of a double salt of ferrous and zirconyl oxalates is reported. The product is crystalline, hygroscopic and golden-yellow in colour having the approximate composition $FeC_2O_4.3\,ZrOC_2O_4.nH_2O$.

Five grams of zirconium nitrate, $Zr(NO_3)_4$, $5\,H_2O$ were dissolved in dilute nitric acid (1 N) and hydroxide was precipitated with ammonia in presence of ammonium chloride. The white precipitate was thoroughly washed with water till free from NH_4^+ and Cl^-, dissolved in oxalic acid solution (0·25 M) and heated on steam-bath for ten minutes. 7·5 gm. of $FeSO_4.7\ H_2O$ were dissolved in water and hydroxide was precipitated in cold and washed as before. The greenish precipitate of slightly oxidized ferrous hydroxide was suspended in the zirconyl oxalate solution, and oxalic acid solution (0·25 M, 25 ml.) was added with stirring and was then heated on steam-bath for 10–15 minutes. Ferrous oxalate partly precipitated out and partly dissolved resulting in a deep yellow solution which was filtered. The filtrate was further concentrated on steam-bath for 15 minutes and then placed in a desiccator for a week. Golden-yellow crystals were formed which were washed a few times with absolute alcohol and dried. The product was analysed. Zr(IV) was estimated gravimetrically as pyrophosphate[2] and also volumetrically by EDTA method[3] and oxalate[4] and Fe(II)[5] by standard methods. (Found: Fe, 5·9; ZrO, 35·6, C_2O_4, 40·3; H_2O, 17·5. $FeC_2O_4.3\,ZrOC_2O_4.9\,H_2O$ requires Fe, 6·3; ZrO, 36·1; C_2O_4, 39·5; H_2O, 18·2%.)

The preparation was repeated a number of times. The analysis of the products shows that iron and zirconyl oxalates are definitely present in the ratio of 1 : 3, although water of hydration varied indicating thereby that Fe(II) and Zr(IV) form at least one double oxalate of the type $FeC_2O_4.3\,ZrOC_2O_4.nH_2O$.

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Dept. of Chemistry, P. C. CHOUDHURY.
M.B.B. College,
Agartala, Tripura, *June* 16, 1969.

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CHEMICAL EXAMINATION OF SOME LICHENS OF *PARMELIA*

AMONG lichens, members of the genus, Parmeliaceæ, are generally found in abundance in all parts of India.[1] They are fairly large in size and could be identified quite readily by their white spots and green colour. A number of these, native to Nepal and Sikkim, have become available and their chemical constituents have now been studied and reported.

Parmelia nepalensis Tayl was collected from Sanguri, 1,000 ft. above sea-level in Nepal, during October. The lichen (400 g.) was extracted successively with petroleum ether (40–60°), ether and acetone, using a Soxhlet. The petroleum ether and ether extracts gave atranorin (0·75%), m.p. 195–196°. The acetone extract gave salazinic acid (5·0%), m.p. 265°(d), *Parmelia cristifera* Tayl, collected from rocks and trees during summer at Rampachodavaram in East Godavari District (Andhra Pradesh), gave atranorin (0·05%) and lecanoric acid (0·1%) from the petroleum ether and ether extracts, and salazinic acid (3·0%) from the acetone extract.

Parmelia reticulata Tayl, obtained from Ooty (Madras State), Sanguri (Nepal) and Anantagiri (Vizag District), gave varying percentages of atranorin (0·8–1·0%) and lecanoric acid (1·0–1·5%) from the petroleum ether and ether extracts and salazinic acid (2·0–2·5%) from the acetone extract.

Parmelia tinctorum Nyl obtained from Bhakur (Eastern Nepal) and Sikkim, collected during October, gave mainly atranorin (1·2%) and lecanoric acid (4·8%) and that obtained from Rampachodavaram (East Godavari District, A.P.) gave mainly atranorin (0·6%) and lecanoric acid (3·0%) while a specimen of *P. tinctorum* collected from Anantagiri (Vizag District) gave lecanoric acid (3·8%), atranorin (1·3%) and norstictic acid (1·1%).

It is interesting to note that lichens of *Parmelia* contain mainly atranorin, lecanoric acid and salazinic acid, although, in some cases, lecanoric acid or salazinic acid was absent.

The occurrence of the various chemical constituents, cited above, are confirmed by comparison with authentic specimens by thin layer chromatography on silica gel layers using Pastuska's solvents mixture[2] (benzene : dioxan : acetic acid, 90 : 25 : 4) as carried out by Ramaut.[3]

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Andhra University, V. Venkateswarlu.
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NATURE OF SUGARS IN *PHOENIX DACTYLIFERA* SEED POLYSACCHARIDE

The tree *Phœnix dactylifera* (N.O. Palmaceæ) occurs in North Africa, Egypt, Arabia, and Punjab (India). The paste of the seeds, made by tituration with water, is said to be applied for opacity of the cornea, and to the head to relieve headaches, and hermicrania. Schulze[1] and co-workers first detected galactomannan in the seeds. Takashi Mizumo and Yachiyo Mikami[2] showed the presence of galactose, mannose, glucose, arabinose, xylose and galacturonic acids in the seeds. But systematic chemical investigation of the seed polysaccharide has not been reported so far. The present communication describes the isolation of the polysaccharide in a pure form, its properties and the nature of the constituent sugars.

Isolation and Purification.—The seeds were washed with 10% sodium carbonate solution (60–70° C.), then with water (60–70° C.) to remove completely the outer covering of the seeds. Subsequently, the seeds were cut into small pieces, soxhleted with alcohol-benzene mixture (2 : 1) for 72 hours. 100 gm. of the soxhleted seeds were powdered and extracted with one litre of 0·5% sodium hydroxide (14 hours) and 2% sodium hydroxide solution (14 hours) successively to remove substances soluble in alkali. The seeds were then thoroughly washed with water to remove dye and other water-soluble salts. Finally, the above alkali-treated seeds powder was extracted with 4% sodium hydroxide solution (1 litre) for 14 hours in an atmosphere of nitrogen. This extraction was repeated thrice. Finally, the extracted alkali solution was filtered, and the filtrate was neutralized with glacial acetic acid upto pH 7 and the crude polysaccharide was precipitated with twice the volume of ethanol. The polysaccharide was found to form an insoluble barium complex with 5% cold solution of barium hydroxide.[3] Advantage of this complex formation was taken to purify and fractionate the polysaccharide. The precipitate so formed was washed with 2% sodium hydroxide. It was then stirred with 50% acetic acid (v/v) for 3 hours to decompose the complex, filtered, and gave two fractions, A (insoluble), and B (soluble) in 50% acetic acid, respectively. The insoluble polysaccharide A was stirred in different percentages of acetic acid (30%, 20%, 10%) then water to remove completely barium ions. It was then dehydrated by stirring in different percentages of alcohol (50%, 70%, 95%, and absolute) and finally kept in acetone for overnight. The soluble polysaccharide B was precipitated from the filtrate by four volumes of ethanol and was deashed, dehydrated as above. Resulting pure polysaccharides were practically ash-free and were used as starting material for the following studies. This indicates that the two polysaccharides are differing in their molecular architecture.

The polysaccharide did not reduce Fehling's solution. Nitrogen, sulphur, halogens, acetyl group, uronic acids were absent. Their preliminary analysis are as follows :

	A.	B
Pentosans percentage	2·29%	1·21%
Pentoses ,,	2·5%	1·38%
Furfural ,,	1·9%	0·63%

Nature of the Sugars.—The two polysaccharides were separately hydrolyzed with N-sulphuric acid, to ascertain the nature of constituent sugars. The course of the hydrolysis was followed by the iodometric titrations, when hydrolysis was complete (10 hours), the solutions were neutralized with barium carbonate and filtered. The resulting solutions were deionized by Duolite C 25 (H)$^+$ and Duolite A 7 (OH)$^-$ ion exchange resins, and concentrated to thin syrups. Paper chromatography by the descending method using *n*-butanol, ethanol, water mixture (5 : 1 : 4—upper layer) and ammoniacal silver nitrate spray reagent, revealed the presence of spots corresponding to galactose (faint), mannose (very strong), and xylose (very faint). The sugar syrup was resolved into pure constituents on a cellulose column with *n*-butanol half-saturated with water. Fractions of the eluate containing pure single sugar were mixed and the sugar was isolated. The identification of the sugars was done by determining their specific rotations, and by preparing their suitable derivatives. The sugars were identified as D-galactose, D-mannose.

In order to determine the ratio of the different constituents sugars in the polysaccharide A, it was hydrolyzed with N-sulphuric acid in sealed tubes separately. The resulting sugar mixture was separated on the Whatman No. 1 chromatographic sheets using *n*-butanol, ethanol, water (5 : 1 : 5—upper layer) as solvent. The corresponding strips of the sugars were cut with the help of guide spots, and were eluted by Dent's[4] method. The eluted sugars were estimated by phenol-sulphuric acid method[5] and periodate oxidation method.[6] Necessary corrections for the blank readings were made. The molar ratio of D-mannose and D-galactose was 12 : 1 in polysaccharide A.

Some information about the nature of linkages in the polysaccharide A was obtained from its infrared spectra. Absorption band at 874 cm.$^{-1}$ was observed, which indicates β linkages in D-mannopyranose units.[7]

The polysaccharide A, which was a major fraction, was taken up for methylation and periodate oxidation studies.

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Dept. of Organic Chemistry, V. K. JINDAL.
National Sugar Institute, S. MUKHERJEE.
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CRYSTALLINE CHEMICAL COMPONENTS OF THE BARK OF *DELONIX ELATA*

Delonix elata Gamble (Syn. *Poinciana elata* Linn. ; family : Leguminosæ) is an ornamental plant growing in several parts of India. Previous work[1,2] reports the presence of L (—) asparagine and aspartic acid. The bark has now been re-examined in a more detailed manner. It was extracted successively with petroleum ether, ether acetone and alcohol.

The petroleum ether extract deposited a fatty ester during concentration which was not examined further. The unsaponifiable matter from the mother liquor when chromatographed over neutral alumina yielded in the petroleum ether : benzene 1 : 1 eluate β-amyrin which was identified through m.p., mixed m.p., $[\alpha]_D$ TLC, elemental analysis and I.R. spectra of the alcohol and its benzoate which were superimposable on those of authentic samples.

The ether extract on concentration and setting aside deposited a solid which after recrystallisation from pyridine was identified as the β-D-glucopyranoside of β-sitosterol, $C_{35}H_{60}O_6$, m.p. 300–10° (*d*) $[\alpha]_D -34°$; tetra acetate, m.p. 170–72°, $[\alpha]_D - 33°$. 2, 3, 4, 6-Tetra-O-methyl-D-glucose was identified on acid hydrolysis of the permethylate. Direct comparison of the glucoside and its acetate with authentic samples employing mixed m.p., TLC and I.R. confirmed the identity. Chromatography of the mother liquor of the above glycoside on neutral alumina yielded β-sitosterol and some more β-amyrin.

No worthwhile compound could be obtained from the acetone extract.

The alcohol extract was reduced to small volume and extracted with *n*-butanol. Acetylation of the residue and purification of the product resulted in the isolation of sucrose acetate. The identity was proved by direct comparison with authentic sample (m.p., mixed m.p. and TLC). The presence of alkaloids in the bark in extremely minute quantity could be detected by usual methods.

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Department of Chemistry, V. HARIHARAN.
University of Delhi,
Delhi-7, *June* 25, 1969.

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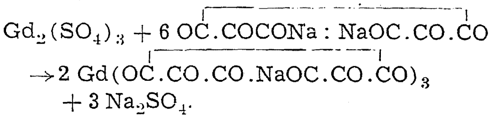
TITRIMETRIC MICRODETERMINATION OF GADOLINIUM : DISODIUM SALT OF RHODIZONIC ACID AS COMPLEXING AGENT

A SIMPLE titrimetric method for the determination of gadolinium is not available in the literature. However, different techniques have been adopted for its determination—in the form of complex compounds with pyrocatechol violet[1]; by ethylenediamine titration[2]; thermogravimetrically[3]; by ion-exchange column[4]; electrometrically[5]; spectrophotometrically[6,8]; by luminiscence[7]; and by titration with sodium tungstate using mixed indicators.[9]

The present work deals with the determination of gadolinium in micro amounts titrimetrically. The method consists in forming a complex, between gadolinium and disodium salt of rhodizonic acid, in the ratio of 1 : 3 and then decomposing it with dilute sulphuric acid, which is then titrated against ceric sulphate solution. Potentiometric titrations and analysis confirm that the complex is formed, between gadolinium and disodium salt of rhodizonic acid, in the ratio of 1 : 3 and at pH 4·9. Probably the following reaction takes place :



$$Gd_2(SO_4)_3 + 6\,\overline{OC.COCONa : NaOC.CO.CO}$$
$$\rightarrow 2\,Gd(\overline{OC.CO.CO.NaOC.CO.CO})_3$$
$$+ 3\,Na_2SO_4.$$

Reagents and Apparatus.—Gadolinium sulphate, ferrous ammonium sulphate, and sulphuric acid (Analar B.D.H. grade); disodium salt of rhodizonic acid and N-phenyl anthranilic acid (L.R., B.D.H. grade); and ceric sulphate (Technical B.D.H. grade).

pH-meter (Northrup, Leeds); micro-pipette and micri-burette. 0·0022 M ceric sulphate (in 8 N H_2SO_4) solution was standardised against standard ferrous ammonium sulphate (in 1 N H_2SO_4) solution using N-phenyl anthranilic acid as indicator.

Standard solution of gadolinium sulphate was prepared by dissolving a weighed amount in distilled water and the solution thus prepared was again standardised.[2]

Procedure.—A known volume of a standard gadolinium sulphate solution is taken, through a micro pipette, in 100 ml. beaker and then diluted by adding distilled water to 20 ml. Excess of fresh disodium salt of rhodizonic acid (0·01 M) solution is added, to the above solution, in such a manner that after boiling, the solution in the beaker is coloured. Actually the pH of gadolinium sulphate (0·01 M) solution, before dilution, was about 5·50 and of disodium salt of rhodizonic acid was 7·0. The mixture was boiled, after adding 15 ml. of 0·01 M disodium salt of rhodizonic acid, for 3 minutes and then cooled to room temperature. Final pH after the completion of the reaction is found to be 4·9. The complex, gadolinium rhodizonate, is filtered and washed with distilled water till the filter-paper is colourless. The filtrate is rejected and the precipitate is dissolved in 2 N H_2SO_4 and then washed with distilled water. The free rhodizonic acid liberated from the dissolved complex in sulphuric acid is estimated against a standard ceric sulphate (in 8 N H_2SO_4) solution using N-phenyl anthranilic acid as indicator, the end-point being a reddish-brown colour.

The results are given in Table I. The range in which gadolinium has been estimated varies from 3·1829 × 10^{-4} mg./l. to 7·9573 × 10^{-4} mg./l.

Table I

Micro-determination of gadolinium

$Gd_2(SO_4)_3$ 0·01 M ml.	$Ce(SO_4)_2$ 0·0022 M ml.	Amount of gadolinium (× 10^4 mg./l.) Taken	Found	Error percentage
0·2	2·76	3·1452	3·1829	1·2
0·3	4·14	4·7178	4·7743	1·2
0·4	5·48	6·2904	6·3174	0·48
0·5	6·92	7·8630	7·9573	1·2

Since the complex between gadolinium and disodium salt of rhodizonic acid is in the ratio of 1 : 3, the observed value is divided by 3. It is observed that 0·0002 N H_2SO_4 is sufficient to disrupt the complex gadolinium rhodizonate. Results show an error of 1·2%. It is observed that 0·5 ml. of 2·002 M salt solutions of Ag, Tl, Au, Co, Ni, Sc, Y, V, La, Ga, Sm; Nd; U; Zn, Zr, Th, In, Ge, and Be ions interfere.

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Chemical Laboratories, O. C. Saxena.
University of Allahabad,
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THE LIVER ADENOSINE TRIPHOSPHATE LEVELS AND ATPase ACTIVITY IN ACETOACETATE ADMINISTERED RATS

It has been reported by Dupasquier[1] and Khmel'ko[2] that the liver of a diabetic rat contains less adenosine triphosphate (ATP) than the liver of a normal rat. Oganesyan[3] observed that the activity of adenosine triphosphatase (ATPase) in diabetic rat liver is greatly suppressed. It is known that the liver mitochondria of diabetic animals exhibit a decrease in their ability to carry out oxidative phosphorylation.[4] These investigations clearly indicate that the diminution in hepatic ATP content and mitochondrial oxidative phosphorylation in the diabetic animals is due to insulin insufficiency. These findings also demonstrate that the decrease in ATPase activity is the main cause of disturbance of glucose transport in the liver and other tissues of diabetic animals.[3]

Extensive studies in this laboratory have revealed that prolonged administration of acetoacetate to animals causes a derangement of the carbohydrate metabolism and leads to several other diabetic symptoms, including degeneration of the β-cells of the pancreas.[5-11] Ohneda[12] has confirmed the findings that the prolonged administration of acetoacetate leads to diabetic conditions in the animals, and he has indicated the mechanism of the development of acetoacetate-induced diabetes through the stimulation of adreno-cortical hormones.

In a previous study[13] on the hepatic mitochondrial oxidative phosphorylation the authors have observed that the long-continued acetoacetate administration to rats results in a significant lessening of P : O ratios, while citrate is used as the substrate. In addition, our recent study[14] of the effect of acetoacetate on mitochondrial ATPase showed a marked inhibition in the enzyme activity both *in vitro* and *in vivo.* In view of the above reports it was felt worthwhile to investigate the changes in the total ATP levels and ATPase activity in the liver of rats injected with acetoacetate.

Male albino rats, each weighing about 140 g., were used in the present experiments. All the rats were kept on a laboratory stock diet, and had free access to water. They were divided into two groups: animals of one group were injected with sodium acetoacetate while those of the other, which served as controls, received physiological saline (0·9%). Acetoacetate was subcutaneously injected once daily for a period of ninety days with a dose of 200 mg./kg. body weight. At the end of every thirty-day interval during the experimental period, the animals were sacrificed by decapitation and the livers were excised and weighed immediately. The hepatic ATP content was determined by the hexokinase method according to Strehler and Totter.[15] ATPase activity on the liver homogenates was assayed by the procedure followed

TABLE I

Variation in the hepatic ATP levels in rats administered with acetoacetate

Experimental treatment			Total liver weight (g.)	ATP (μ moles)		Percentage difference (μ moles per g. liver)
Group	No. of animals	Period in days		Per g. liver	Per liver	
Normal ..	6	..	2·843 (±0·054)	1·42 (±0·04)	4·14 (±0·26)	..
Normal + ACE ..	8	30	2·838 (±0·057)	1·41 (±0·04)	4·08 (±0·22)	< 1
,, ..	8	60	2·846 (±0·055)	1·05 (±0·05)	2·96 (±0·17)	26
,, ..	7	90	2·840 (±0·051)	0·87 (±0·03)	2·42 (±0·14)	39

ACE, acetoacetate administration. Values refer to the means, with standard deviations comprised in parentheses. All data are given on the wet weight basis of liver.

TABLE II

Total liver ATPase activity in normal and acetoacetate-administered rats

Experimental treatment			Liver protein (mg./g. tissue)	Activity of enzyme*		Percentage inhibition (as per g. liver)
Group	No. of animals	Period in days		Per g. liver	Per liver	
Normal ..	4	..	156·83 (±7·7)	34·6 (±2·2)	97·2 (±4·3)	..
Normal + ACE ..	6	30	155·41 (±6·3)	23·5 (±1·9)	69·3 (±3·8)	32
,, ..	6	60	153·70 (±7·1)	18·6 (±1·7)	54·1 (±3·5)	46
,, ..	5	90	154·29 (±6·5)	16·5 (±1·7)	48·7 (±3·4)	52

ACE, acetoacetate administration. Values refer to the means, with standard deviations comprised in parentheses. All data are given on the wet weight basis of liver. * μ moles Pi liberated from the substrate, ATP/mg. protein/20 min.

by Reddi and Nath.[16] Protein was measured by the method of Lowry *et al.*[17] Acetoacetate was prepared as described by Tidwell and Nagler.[18]

Table I shows the rat liver ATP levels at different time intervals of acetoacetate administration, together with the percentage difference. In animals receiving acetoacetate there was a marked decline in the liver ATP levels. Both after sixty and ninety days of the experimental period, a considerable fall in the ATP content was noticed in the liver of the rats administered with acetoacetate, although the changes at the end of thirty days were not appreciable. Table II represents the results of the experiments, in which inhibition of the liver ATPase activity in acetoacetate-administered rats was observed. Acetoacetate produced a distinct decrease in the ATPase activity even towards the end of first thirty days of the experimental period. The effect of acetoacetate on this enzyme in liver homogenates looks similar to that found before with liver mitochondria, and these observations here described confirm our earlier findings.[14]

Hall *et al.*[4] have reported a decreased ability of mitochondrial oxidative phosphorylation in diabetic rat liver. That the liver mitochondria from acetoacetate-administered rats show a decreased efficiency to carry out oxidative phosphorylation has earlier been reported by Nath and his co-workers.[13] Previous studies[1,2] show that the ATP content in diabetic rat liver is markedly diminished due to insulin insufficiency. In our present investigations, the diminution in the liver ATP levels following acetoacetate administration to rats seems to be attributable to the fact that, the ability by the liver miochondria to carry on oxidative phosphorylation is markedly impeded. Also, insulin deficiency which is caused by prolonged acetoacetate injection[5,6] may be a responsible factor that cannot be overlooked for the observed changes in ATP and ATPase activity in the liver.

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Dept. of Biochemistry, T. G. REDDI.
Nagpur University, B. SIVAKUMAR.
Nagpur, *August* 8, 1969. M. C. NATH.

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SOME AGGLUTINATED FORAMINIFERS FROM THE MINIYUR GROUP OF THE CRETACEOUS FORMATION, TRICHINOPOLY AREA, S. INDIA

THE South Indian Cretaceous rocks have in recent times been receiving much attention from micropaleontological and biostratigraphical points of view. The pioneer work was carried out by Blanford (1862), followed by Warth (1895) and Kossmat (1895). Rama Rao (1936, 1956) has pointed out the distinctness of the 'Niniyur group' besides indicating its lithological constituents.

A detailed micropaleontological analysis of the gritty and compact limestones of the Niniyur formation has revealed the occurrence of a number of agglutinated Foraminifers not reported earlier anywhere from the rocks of this area.

Mapping of the exposures covering an area of about 28 square miles in the northern part of Niniyur formation of the Trichinopoly Cretaceous area was carried out. The gritty and compact limestones were collected from stream cuttings, nallas and well sections. As many as 250 samples drawn from outcrops near the villages —Niniyur, Udaiyankudikkadu, Sendurai and Authencoorchy, have yielded microfossils such as Foraminifers and Ostracodes. A detailed study of the Foraminifers has revealed the presence of agglutinated forms. Following the Russian system of classification given by Orlov, J. A. (1962), these agglutinated Foraminifers can be grouped into 18 species belonging to 9 genera and 4 families of the Order Astrorhizida. These species are as follows: Order Astrorhizida, Superfamily Astrorhizidea, Family Astrorhizidæ—*Rhabdammina* sp., *R. irregularis* Carpenter, *R. abyssorum* M. Sars, *R. discreta* Brady, *R. cylindrica* Glaessner, *Crithionina dubia* Bulatova; Family Rhizamminidæ—*Rhizammina indivisa* Brady, *R. algœformis* Brady, *Bathysiphon nodosariaformis* Subbotina, *B. multiformis* Bulatova, *B. rzehaki* (Andreae), *B. aff. ruffescens* Cushman, *Arenosiphon* sp.; Family Hyperamminidæ—*Hyperammina* sp.; Family Saccamminidæ—*Tholosina* sp.

The detailed study pertaining to the description and biostratigraphic significance of the species identified is under progress.

The authors are highly indebted to Professor M. N. Viswanathiah for his constant encouragement and help. One of the authors (M. N. Malur) gratefully acknowledges the financial assistance given by the University Grants Commission for undertaking this work.

Dept. of Geology, V. VENKATACHALAPATHY.
Mysore University, M. N. MALUR.
Manasagangotri,
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PREPARATION OF A SOURCE OF Lu_{71}^{171}

WE describe the preparation of a thin source of Lu_{71}^{171} for β-ray spectroscopy.

The internal beam of the alpha-particles of the Synchrocyclotron of the Lyons University hit a target of Tu^{169} with an intensity of 5 microamperes, the total charge on the target-support being 35 microampere-hours, and the energy of the projectile 30 Mev. The activity of Lu^{171} was more preponderant than that of Lu^{172}. There were no noticeable traces of

Lu^{170}. Chromatographic separation was employed over a Dowex Column 50 × 12 cm. for 6 hours with the aid of alpha-hydroxy-isobutyric at pH 3·7. The fraction of the recuperated Lu^{171} was placed at pH 1 with HNO, 8 N charged over a Dowex Column 50 × 12 cm. in the form of H +, and 100 c.c. of distilled water percolating. The activity was collected by HNO_3 in the first two c.c. of the Column. To get all the activity, two slow reductions at dryness conditions were necessary.

This fraction in the presence of acetic acid 0·01 N, and alcohol in the ratio 1 : 1 was placed in an electro-deposition cell, whose capacity was 0·1 c.c. A current of 1 m A provoked electrolysis of the rare-earth hydroxide at the cathode, constituted by a platinum wire of 100 microns.

The source was then placed in a semi-circular spectrograph to study the low energy conversion electron spectrum. Preacceleration was employed to accelerate the electrons, and nuclear emulsion plates were used as detectors.

This work is a part of the Doctoral Thesis, presented by the author at the Lyons University in 1967.

Institute of Geology,
1, rue Blessig,
Strasbourg University,
France, *July* 1, 1969.

M. ANTONY.

ON A NEW SPECIES OF *LITHOPORELLA* FOSLIE (CORALLINE ALGAE) FROM THE BAGH BEDS OF MADHYA PRADESH

THE present communication reports a new species of *Lithoporella* Foslie from the Upper Coralline Limestones of the Bagh Beds of M.P. Fossil algæ from the Bagh Beds have been reported by Chiplonker (1944), Singh (1950), and more recently by Ghosh and Pal (1968, 1969) and Pal (1968).

The term *Lithoporella* was used by Foslie in 1904 (Weber van Bosse and Foslie, p. 73) for thin crustose coralline algæ whose thalli are built of one or only a few layers of cells, as a subgenus under *Mastophora,* with *Mastophora melobesioides* Foslie as its type. Later, Foslie (1909, p. 59) raised *Lithoporella* to full generic rank. This was accepted by most American geologists, and Marshall A. Howe (1919, p. 17) states: "Foslie's establishment of a genus *Lithoporella* to receive the monostromatic calcified forms that he had previously referred to *Mastophora* seems justified". However, Mme. Lemoine (1917, p. 174) preferred to consider *Lithoporella* as a subgenus under *Melobesia.* In recent years, American geologists have tended to follow Howe's example and consider *Lithoporella* as an independent genus, while European geologists and botanists have followed Mme. Lemoine.

Lithoporella has very thin monostromatic crustose thalli except around conceptacles where they thicken, and several layers of smaller cells may be present. The cells are rectangular, vertically elongated, and form a palisade-like layer. Rhizoids are absent. The thalli commonly grow superimposed or alternating with other crustose algæ or encrusting foraminifers to form thick crusts. Conceptacles are large, with a single aperture.

Lithoporella closely resembles *Mastophora* Decaisne, but *Mastophora* has long rhizoids for attachment, and normally the thalli do not grow superimposed. Another genus of close resemblance is *Heteroderma* Foslie which differs from *Lithoporella* in consisting of one or two layers of isodiametric cells which are not vertically elongated to form palisade-like layers. Adjacent thalli become confluent but never superimposed. *Melobesia* Lamouroux differs from *Lithoporella* by having horizontally elongated cells in the basal layer; the thallus may be several layers thick and the conceptacles have a number of openings.

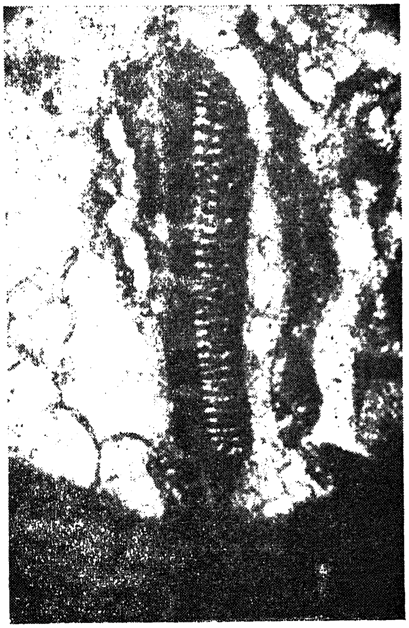

FIG. 1, × 100.

TABLE I

Dimensional data of principal Lithoporella *species (in μ)*

		L. melo besioides (Foslie) Foslie	*L. elliotti* Emberger	*L. antiquitus* Johnson	*L. crassa* Ishijima	*L. longicella* Johnson	*L. atlantica* Foslie	*L. conjucta* Foslie	*L. indica* n. sp.
Cell:									
Height	..	(20) 25–85 (104)	80–140	30–60	34–45	45–104	32–60	36–55	64–104
Width	..	(10) 15–30 (64)	20–24	13–22	11–15	9–15	18–40	14–40	16–24
Conceptacles:									
Diameter	..	600–1000	..	175–250	..	..	500–800	400–800	240–280
Height	..	130–264	..	95–115	..	..	..	..	140–160
Age	..	Jurassic to recent	Jurassic	Miocene	Pleistocene to Recent	Pleistocene to Recent	Recent	Recent	Upper Cretaceous
Ref.	..	Foslie, 1909, pp. 58, 59	Emberger, 1957, pp. 625–629, pl. 1, fig. 1	Johnson, 1961. p. 937, pl. 276, figs. 1, 2	Ishijima, 1945. pl. 48, figs. 1–3, pl. 49, figs. 1–3	Johnson, 1961, p. 937, pl 276 figs. 3–4	Foslie, 1909	Foslie, 1909	..

Systematic Description

Phylum : RHODOPHYCOPHYTA (Red Algæ)
Family : CORALLINACEAE (Coralline Algæ)
Subfamily : MELOBESIOIDEAE (Crustose Coralline Algæ)
Genus : *Lithoporella* Foslie, 1909.

Lithoporella indica n. sp.

Description.—Thallus a single layer of long, vertically elongated, narrow palisade cells which show a considerable range in size in a single thallus. Cells 64–104 μ high and 16–24 μ wide. Thickening around conceptacles where 2–3 layers of smaller cells are observed. Conceptacle 240–250 μ × 160 μ with a single aperture, 40–48 μ wide.

Remarks.—Though the cell dimensions are within the great size range of *Lithoporella melobesioides* Foslie, the present material differs in having a much higher height/width value of cells, as also in the dimensions of conceptacles which are much smaller. It closely resembles *Lithoporella crassa* Ishijima or *Lithoporella longicella* Johnson, but these are "strictly monostromatic" and show superimposed thalli which are not observed in any of the present specimens. Further, *Lithoporella crassa* has shorter cells and the Pleistocene-Recent material described as *Lithoporella longicella* has not yielded any conceptacle (Table I).

Figured Slides.—C.L. 103, C.L./06, C.L./18/1.

Horizon and Locality.—Upper Cretaceous (Mæstrichtian); Mohanpura.

Table I gives the dimensional data of the major fossil species of *Lithoporella.*

The author is indebted to Prof. A. K. Ghosh, Department of Botany, Calcutta University, who suggested the problem and guided the work.

Palæobotany Laboratory, A. K. PAL.
Department of Botany,
Calcutta University,
Calcutta-19, *May* 1, 1969.

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THE PHYSIOLOGY OF THE WOODLOUSE, *PORCELLIO LEAVIS* LATREILLE (PORCELLIONIDAE, PERACARIDA)

V. The Fructose-1, 6-Diphosphate Aldolase of the Body Tissue*

THE enzyme, fructose-1, 6-diphosphate aldolase, originally discovered in the yeast,[14] acts as a catalytic agent in the reversible reaction between dihydroxyacetone and the aldehydes, acetaldehyde, glyceraldehyde, glycolaldehyde, glycolaldehyde-2-phosphate, etc., for the release of the corresponding phosphorylated derivative.[5] In general, aldolase is absolutely specific to one of the products only, namely, dihydroxyacetone phosphate, while it is group-specific towards the other.

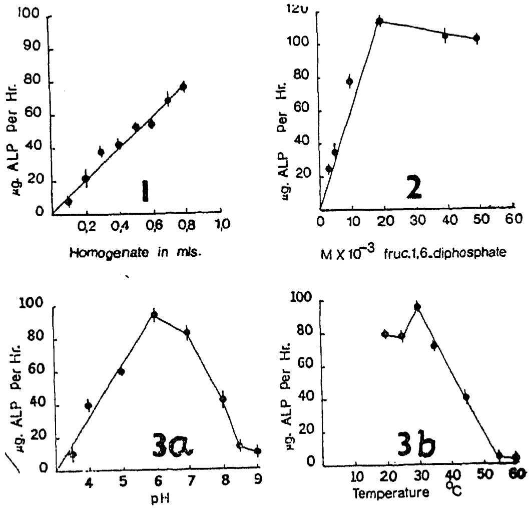
Crystalline aldolase has been prepared from rabbit muscles,[11] and some of its characteristics have been described from the extractions made from *Clostridium perfrigens*,[3] *Trypanosoma cruzi*,[2] *Trichomonas vaginalis*,[1] *Tœnia crassiceps*,[8] *Tribolium confusum*[6] and the mosquitoes.[9]

In Isopoda, very little information is available on the intermediary glycolytic cycle and virtually none concerning the biochemical properties of the specific enzymes of this pathway.

The body-tissue aldolase from the mature *Porcellio* adult, weighing around 400 mg., was extracted, in a VirTis 23 microblender, with ice-cold water. The reaction mixtures were prepared according to Sibley and Lehninger.[15] To ascertain the effect of metal ions on the aldolase activity, the procedure of Chaudhary *et al.*[6] was followed. The colour intensities were measured against the blank in a B and L DU-2 spectrophotometer at a 540 mμ (± 40 mμ) wavelength, and following the technique of Fiske and Subba Row,[10] as modified by Horwitt,[12] enzyme activity was defined in terms of micrograms of alkali-labile-phosphate (ALP) per hour at 37° C.

The effect of substrate concentration on the woodlouse aldolase reaction velocity, measured at 37° C. and at 8·6 pH, is presented in Fig. 2. Generally speaking, a more or less proportional increase in the cleavage of the fructose-1, 6-diphosphate resulted from a corresponding increase in the substrate up to a final concentration of around $23 \cdot 8 \times 10^{-3}$ M. The apparent Michaelis-Menten constant (K_m), calculated by the method of Lineweaver and Burk,[13] was approximately $3 \cdot 5 \times 10^{-3}$ M. With the same substrate, Chaudhary *et al.*[6] reported a K_m value of $1 \cdot 2 \times 10^{-3}$ M. for *Tribolium* aldolase, while in case of mosquitoes a K_m value range of $3 \cdot 2 \times 10^{-3}$ M to $3 \cdot 6 \times 10^{-3}$ M has been reported by Phifer.[9]

The effect of enzyme concentrations on the reaction velocity was ascertained by varying the amount of *Porcellio* homogenate from 0·2 ml. to 0·8 ml., by 0·1 ml. steps, in the incubation mixture. As shown in Fig. 1, at these enzyme concentrations there was a linear relationship between the enzyme concentrations and the amounts of the by-products released. Identical results have been reported by Phifer[9] with *Aedes* aldolase. In case of *Tribolium*, according to Chaudhary *et al.*,[6] a zero order reaction was retained only if the amount of the aldolase did not exceed the equivalent of 2·5 mg. of protein.



FIGS. 1–2, 3*a* & 3*b*

The temperature and the H^+ ion requirements of the woodlouse aldolase are shown in Figs. 3*a* and 3*b*. It is shown that although the enzyme remained active within the temperature range of 20° C.–40° C., the maximum hydrolysis of the substrate took place at pH 6·0 and at 30° C. Chaudhary *et al.*,[6] who employed Tris buffer, reported a pH optimum of 8·0–9·0 for *Tribolium* aldolase as did Sibley and Lehninger[15] for the vertebrate muscle aldolase. In studies[1–3] where buffers other than Tris were employed, an optimum pH range 7·0–7·5 has been given. This implies that the optimal pH range of the aldolase of the biological systems so far studied falls within the narrow limits of pH 6·0 to 9·0.

The effects of various metal ions and a metal-complexing agent on the woodlouse aldolase activity are summarized in Table I.

TABLE I

Effect of metal ions and the metal-complexing agent on the woodlouse aldolase activity

Agent		Aldolase activity (in micrograms of ALF/hr. at 37°C.)	Inhibition (percentage)
Control	..	24·0	0·0
Ethylenediaminetetraacetate (EDTA) (10^{-2} M)		56·0	..
EDTA (10^{-2} M) + $MgSO_4$ (10^{-2} M) (50 : 50, v/v)		38·0	..
$MgSO_4$ (10^{-2} M)	..	1·9	90·5
EDTA (10^{-2} M) + $CaCl_2$ (10^{-2} M) (50 : 50, v/v)		65·2	..
$CaCl_2$ (10^{-2} M)	..	3·2	84·0

It was observed that whereas magnesium and calcium ions both tended to inhibit the catalytic activity of *Porcellio* homogenate, the effect of the addition of ethylenediaminetetraacetate was to reverse the effect of the inhibition induced by the metal ions. This implies that the woodlouse body-tissue aldolase is very similar to the aldolase found in vertebrate muscles.[4,16,17]

On the basis of these investigations it is concluded that the Embden-Meyerhof glycolytic cycle, somewhat identical to that observed in Vertebrata[14] and Insecta,[7] is present in this isopod. The significance of the contribution of this glycolytic pathway to the energy economy of *Porcellio*, however, requires further clarification.

I am very grateful to Dr. W. Y. Watson for his stimulating discussions on the problem and for reviewing the manuscript, and to the National Research Council of Canada for the financial support.

Départment de Biologie,
Université Laurentienne
de Sudbury,
Sudbury, Ontario, Canada, *May* 12, 1969.

M. A. ALIKHAN.

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* Contribution No. 6 from the Biology Department of the Laurentian University of Subdury, Ontario, Canada.

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INDIAN PEAT AS A CARRIER OF *RHIZOBIUM*

PEAT has been widely used as a carrier of *Rhizobium* because of its high content of organic matter, aeration and water-holding capacities. The survival of the applied rhizobia in the material is high.[1,4-8] Soils rich in organic matter are also used in the preparation of legume inoculants in this country but peat has not so far been tried or used. It has been possible now to obtain peat from a few places in India and the present investigation dealing with the possibility of using available Indian peat as carrier material for *Rhizobium* has been carried out with the sample obtained from Soil Conservation Research Demonstration and Training Centre, Ootacamund (Nilgiris). This peat had 50% organic matter.

The peat, dried in the sun, powdered and sieved through 60 mesh was found to have a pH value of 4·6. This was adjusted to 6·8 by the addition of 10% $CaCO_3$. The mixture was sterilised for 4 hours at 121° C. in glass bottles. An efficient strain of *Rhizobium japonicum* was grown in yeast-extract-mannitol medium and shaken continuously on a rotary shaker for 7 days at 28–30° C. 50 ml. of this (having a tire value of $18 \cdot 5 \times 10^{11}$/ml.) were added to the peat and incubated at temperatures of 28°, 35° and 40° C.

Plate counts were made by standard dilution procedures on the yeast-extract-mannitol-agar medium containing Congo red.[2,3]

The data in Table I illustrate the influence of temperature on the growth of the organism per g. of peat (average of duplicates).

These counts were very much higher as compared to those of the soil culture where the maximum count recorded was of the order of out 1×10^8 cells/g., when the temperature s increased to 35° C. the counts were nil. e above data show the superiority of peat er the soil for the survival of the organism.

TABLE I

Period		Temperature °C.		
		28	35	40
week	..	$4 \cdot 6 \times 10^9$	30×10^{11}	80×10^4
d ,,	..	49×10^{11}	35×10^{11}	11×10^4
,,	..	34×10^{11}	90×10^{10}	5×10^1

The results of this investigation show that dian peats are quite suitable as carrier aterials and can be used in the final stage of preparation of legume inoculants.

vision of Microbiology, V. ISWARAN.
dian Agricultural W. V. B. SUNDARA *RAO*.
Research Institute, S. P. MAGU.
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A STRAIN OF *ASPERGILLUS NIGER* PRODUCING CALCIUM GLUCONATE

E technique of induced mutation and strain ection is now being extensively practised in dustrial microbiology with a view to improv- the existing strains. A project of strain velopment was undertaken in this laboratory order to secure improved strains of *pergillus niger* showing higher yield of cium gluconate. Several mutagens were d in this investigation and the encouraging ults obtained are reported in this paper.

The parent strain used in the investigation s *Aspergillus niger* strain A-15. It was ected out of fifty isolates of the fungus lected from various sources. It produced average of 5·6 g. of calcium gluconate per ml. of fermentation broth. Fermentations re run in stationary flask cultures at 28–29° C. d broth was harvested on the 10th day of ubation. The fermentation medium con- ned (g./1) glucose 12·0; $(NH_4)_2HPO_4$ 0·39; KH_2PO_4 0·19 and $MgSO_4 \cdot 7H_2O$ 0·16. $CaCO_3$ (2·5%) was sterilized separately and added to the medium after sterilization. Calcium gluconate was estimated by determining calcium in the broth by titration with EDTA. The formation of calcium gluconate was confirmed by paper chromatographic separation of gluconic acid in the broth after removing calcium by ion-exchange.

The parent strain was treated with UV rays of 2537 Å emitting energy at 100 ergs/mm.^{2}/sec. Spores were treated with UV rays according to the following scheme:

UV rays......sunlight......UV rays
(8 minutes) (8 minutes) (8 minutes)

Of the surviving substrains 400 cultures were tested for calcium gluconate production. The best mutant of this population was AU 8170, producing an average of 7·7 g. of calcium gluconate per 100 ml. of fermentation broth. This mutant was next subjected to combined treatment with formalin (0·03 M) and UV radiation, each time for 8 minutes. 400 substrains were tested for calcium gluconate yield. The best of this population was AFU 336 which produced an average of 9·0 g. of calcium gluconate per 100 ml. medium. This mutant was then treated with γ-radiation from Co–60, and doses administered were 20 Kr., 30 Kr., 40 Kr. and 50 Kr. For each dose 400 substrains were studied for calcium gluconate yield, and the best mutant of this experiment was AG 525, derived from treatment with 50 Kr. This mutant produced an average of 9·9 g. of calcium gluconate per 100 ml. of medium, thus proving to be superior to the original parent by about 1·8 times.

The mutant will next be grown in submerged culture condition and results will be reported in due course.

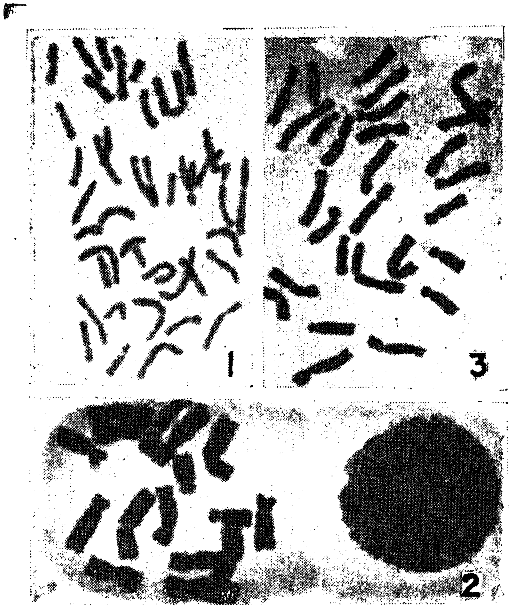
This investigation has been carried out under a scheme granted by the National Institute of Sciences of India to one of us (A. D.).

Dept. of Microbiology, ARATI DAS.
Bose Institute, P. NANDI.
93/1, Acharya Prafulla
Chandra Road,
Calcutta-9, *June* 19, 1969.

CYTOGEOGRAPHY OF THREE SPECIES OF *CHLOROPHYTUM*

MORE specialized karyotypes have usually been known from the regions away from the centre of diversification. To ascertain if there existed some correlation between the geographic distribution pattern and karyotype evolution, the karyotypes of two uninvestigated Indian and one African species of *Chlorophytum* have been analyzed in the present study. The genus contains over 300 species with its probable centre of diversification in tropical and subtropical Africa where over 85% of the species are found (Hooker and Jackson[1]). About 16 species have been reported from India. Two basic chromosome numbers 7 and 8 were reported for the genus—based on less than 20% of the total number of species (Darlington and Wylie[2]). *C. arundinaceum* Baker was collected from Bihar (India) while plants of *C. tuberosum* Baker and *C. elatum* var. *variegatum*, were obtained from Poona (India) and Uganda, respectively. The chromosome counts and karyotype analysis were made from the somatic metaphase plates. Stebbins'[3] classification of referring to asymmetry trends has been used: the location of centromere, based on (*i*) the proportion of chromosomes with arm ratio greater 2 : 1 (P) and (*ii*) the size difference ratio (R) between the longest and shortest chromosomes.

1. *Chlorophytum arundinaceum* : $2n = 42$ (Hexaploid); Fig. 1



FIGS. 1–3. Photomicrographs representing the metaphase plates of *Chlorophytum arundinaceum* ($2n = 42$); *C. tuberosum* ($2n = 16$): and *C. elatum* var. *variegatum* ($2n = 28$) respectively, × 1,050.

Kurosawa[4] reported chromosome number $2n = 84$ but did not describe the karyotype of the species. The asymmetrical karyotype consists of 5 pairs of relatively long, 10 pairs of medium and 6 pairs of short chromosomes. Six pairs of chromosomes (3 long, 2 medium and 1 short) possess secondary constrictions. Secondary constrictions in the respective homologues could be located with difficulty. Slight structural heterozygosity was also observed in certain chromosome pairs. Karyotype asymmetry falls in Stebbins' '3 b' category (P = 0·[illegible]; R = 3·2). It is one of the relatively evolved karyotypes reported from India away from the centre of diversification of the genus.

2. *Chlorophytum tuberosum* : $2n = 16$ (Diploid); Fig. 2

Kumar and Rao[5] reported chromosome number $n = 8$. However, the karyotype of the species remained unknown (Fig. 2). The asymmetrical karyotype consists of 3 pairs of relatively long, 4 pairs of medium and 1 pair of short chromosomes. One pair of long chromosomes possesses subterminal secondary constriction in short arm.

C. tuberosum also falls in '3 b' category of karyotype asymmetry (P = 0·62) but unlike *C. arundinaceum* does not show marked size difference ratio (R 2·1) but rather an increase in the proportion of subterminal chromosomes (P = 0·62), indicating a shift towards the terminal location of centromere.

3. *Chlorophytum elatum* var. *variegatum* $2n = 28$ (Tetraploid); Fig. 3

The asymmetrical karyotpye (P = 0·[illegible]; R = 2·3) consists of one pair of relatively long, 9 pairs of medium and 4 pairs of short chromosomes. One pair of the short chromosomes was observed to posses a satellite on the short arm.

Sato[6] reported a slightly asymmetrical karyotype (P = 0·64; R = 2·0) with 2 pairs of satellite chromosomes. While Sharma and Chatterji[7] reported from the Indian taxon a slightly more asymmetrical karyotype (P = 0·[illegible]; R = 2·6) but with two pairs of chromosomes having submedian secondary constrictions unlike the present investigation and that of Sato.[6] However, all the three types conform to '3 b' category of Stebbins' classification of karyotype asymmetry, with African biotype possessing slight karyotypic symmetry over that of Indian type.

The above sample study of karyotype comparison of the taxa from different geographical regions does not provide a clear picture of the relationship between the distribution pattern and the karyotype evolution perhaps owing to inadequacy of cytological data. The detection of the diploid taxon in S. India, however has been enigmatic. This genus offers a good case study for a cytogeographer.

The authors are thankful to Dr. Rolla Seshagiri Rao, B.S.I., Poona, and Mr. K. S. Kalsi, Uganda, for sending us materials of *C. tuberosum* and *C. elatum* var. *variegatum*, respectively. Grateful thanks are due to Dr. M. S. Swaminathan, Director, IARI, New Delhi, for kindly going through the manuscript and Shri M. H. Musavi, Principal, Delhi College, Delhi, for facilities.

Division of Genetics, A. N. Pahuja.
IARI, New Delhi-12,
and
Dept. of Botany, Virendra Kumar.
Delhi College,
Delhi University, *June* 9, 1969.

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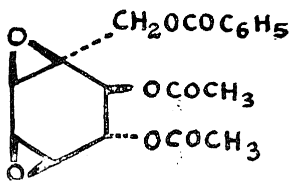
CROTEPOXIDE, AN ANTITUMOUR PRINCIPLE FROM *PIPER HOOKERI* STEMS

Plants belonging to the genus *Piper* (Fam.: Piperaceæ) are known to possess considerable medicinal and economic properties. During the course of investigation on *Piper* species we have isolated crotepoxide (I) a novel cyclohexane diepoxide having a diacetate and monobenzoate function. Very recently, two publications have appeared of this *only* naturally occurring cyclohexane diepoxide compound from *Croton macrostachys*[1] (crotepoxide I) and from *Piper futokadzura*.[2] Kupchan *et al.*[1] confirmed its structure by X-ray analysis and found it to possess significant antitumour activity. One kg. of the stems of *P. hookeri* Linn. extracted with petroleum ether in a Soxhlet deposited on concentration a crystalline residue which on refluxing several times with petroleum ether and subsequent crystallisation from methanol gave crotepoxide (I) (310 mg.), m.p. 148–49° (reported[1] : 150-51°). It had identical TLC, U.V., i.r., n.m.r., mass and crystalline derivatives to that of crotepoxide (Found: C, 60·2; H, 5·01 $C_{18}H_{18}O_8$ requires: C, 59·66; H, 4·97%). It had $[\alpha]_D^{20} + 72$ (C, 2·0 $CHCL_3$); $\lambda_{Max.}^{MeOH}$ 230 mμ, 278 mμ and 285 mμ; $\nu_{max.}$ KBr), 1768, 1755, 1730, 1600, 1240 and 724 cm.$^{-1}$'; δ ppm ($CDCL_3$) 2·02 (3 H, S), 2·12 (3 H, S), 3·10 (IH, *q*), 3·45 (IH, *q*), 3·66 (IH, *d*) 4·23 (IH, *d*) 4·58 (IH, *d*), 4·96 (IH, *q*) 5·73 (IH, *d*) and 7·47–8·03 (5 H, *m*) and the M^+ at 362 and the other fragmentation peaks at 227, 207, 194, 163, 138, 122, 115, 105, 97, 77. The compound on hydrolysis with alc. KOH gave benzoic acid, on treatment with methanolic HCl gave a dichlorohydrin m.p. 240–41° (reported[1] : 241–42°) and on hydrogenation with PtO_2 gave a hexahydro derivative (n.m.r.) m.p. 119–20° (reported[1] : 121–22°). Its identity was confirmed by mixed m.p. with an authentic sample of futoxide (Crotepoxide I) with no depression in m.p.



The authors are thankful to Dr. D. G. H. Crout, University of Exeter, England, for providing the spectral data and to Dr. A. Ogiso, Cent. Res. Lab., Sankyo Co. Ltd., Tokyo, Japan, for providing a sample of Crotepoxide (futoxide).

Regional Res. Laboratory, Jagdev Singh.
Jammu-Tawi (India), K. L. Dhar.
June 19, 1969. C. K. Atal.

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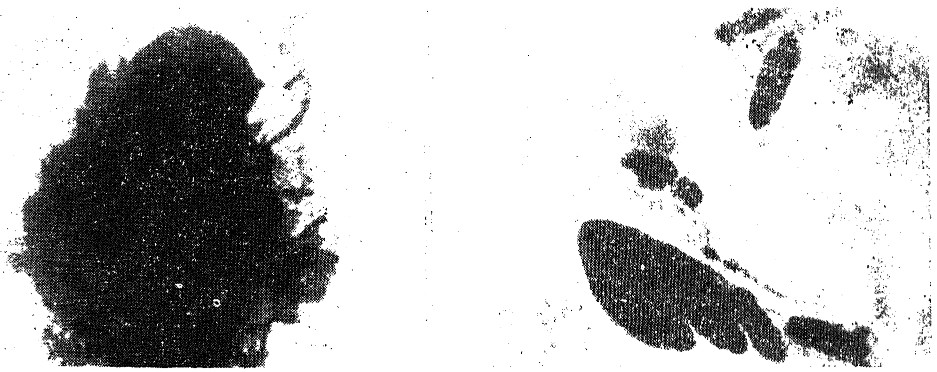
A NEW LEAF SPOT DISEASE OF WHEAT IN INDIA

In a varietal trial of wheat during November, 1967 at Sabour a new leaf spot was observed on two-week old seedlings of variety NP 884. The spots measured 1–2·5 × 0·5–1 mm. and were brown in colour.

On microscopic examination of the spots no evidence of sporulation was observed. The spot was disinfected with 0·1% mercuric chloride solution, washed in several transfers of sterile water and put aseptically into autoclaved PDA slant for isolation. The test-



FIGS. 1–2. Fig. 1. Showing: A Perithecium, B. Ascus and Ascospore of *Leptosphærulina trifolii* (Rostr.) Petrak.

tube stored at 28° C yielded mature perithecia of the following description in 23 days.

Perithecia dark, elongated, irregular in shape, papillate and measured 104–376 × 96–288 μ (Fig. 1 A); asci clavate to cylindrical, slightly curved, somewhat rounded at the apex, paraphyses or paraphysoids lacking, typically 8-spored, 70–96 × 26–34 μ (Fig. 1 B); ascospores muriform, light brown, both transversely and longitudinally septate with mostly 4-transverse and 2-longitudinal septa, 24–34 × 8–12 μ (Fig. 1 B). The above characters of the perithecia, asci and ascospores conform with the characteristics of *Leptosphœrulina trifolii* (Rostr.) Petrak.

Pandey and Wilcoxson[1] (1967) worked on a common foliage pathogen on alfalfa (*Medicago sativa* L.) in the cool humid parts of the United States caused by *L. briosiana* (Poll.) Graham and Luttrell. The occurrence of *L. trifolii* (Rostr.) Petrak on wheat appears to be the first record from India or elsewhere.

A slide of the fungus (Perithecia, asci and ascospores) has been deposited in the C.M.I., Kew, England, as no. IMI 134893.*a*.

Sincere thanks are due to Dr. M. B. Ellis and Dr. C. Booth Commonwealth Mycological Institute, Kew, England, for the identification of the fungus.

Tirhut College of
Agriculture,
P.O. Dholi,
Muzaffarpur (Bihar),
June 9, 1969.

A. P. MISRA.
R. A. SINGH.
B. MISHRA.

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BLOOD PROTEINS OF *SCOLOPENDRA MORSITANS*, A CENTIPEDE (CHILOPODA : MYRIAPODA)

STUDIES on the blood proteins of millipedes reveal the presence of 6 protein fractions, of which one fraction resembles fibrinogen of the human serum, and the same may be responsible for the coagulation of blood in these myriapods.[1,2] But though it is known that unlike in millipedes the blood in centipedes does not coagulate,[2] no attempt has so far been made to characterize the blood proteins of chilopods, hence this study.

Centipedes of the species *Scolopendra morsitans*, in intermoult stage, were used as materials. Blood was collected from 25 centipedes through a puncture made on the mid-dorsal line of the body and was pooled. About 25 to 30 μl. of the blood was spotted on a narrow strip of Whatman No. 1 filter-paper and used for electrophoretic run as described elsewhere.[1] The electropherograms were prepared according to Giri.[3] The agar solution for spreading the plates was prepared by mixing equal volumes of 1% agar in water and veronal-acetate buffer of pH 8·6 and ionic strength 0·1. The electropherograms were run for 7 hours at a constant current flow of 4 ma per plate and at a voltage gradient of 250 V throughout the period. Amidoblack was used for dyeing. The curves for the pherograms were obtained with Carl Zeiss extinction recording apparatus.

Figure 1 shows the general blood protein pattern of *Scolopendra morsitans*, compared to that of human serum. The blood of the centipede reveals the presence of 5 protein fractions. The protein bands have been numbered 1 to 5 starting from the one with fastest anodic migration, and they will be referred to as protein 1, protein 2, etc.

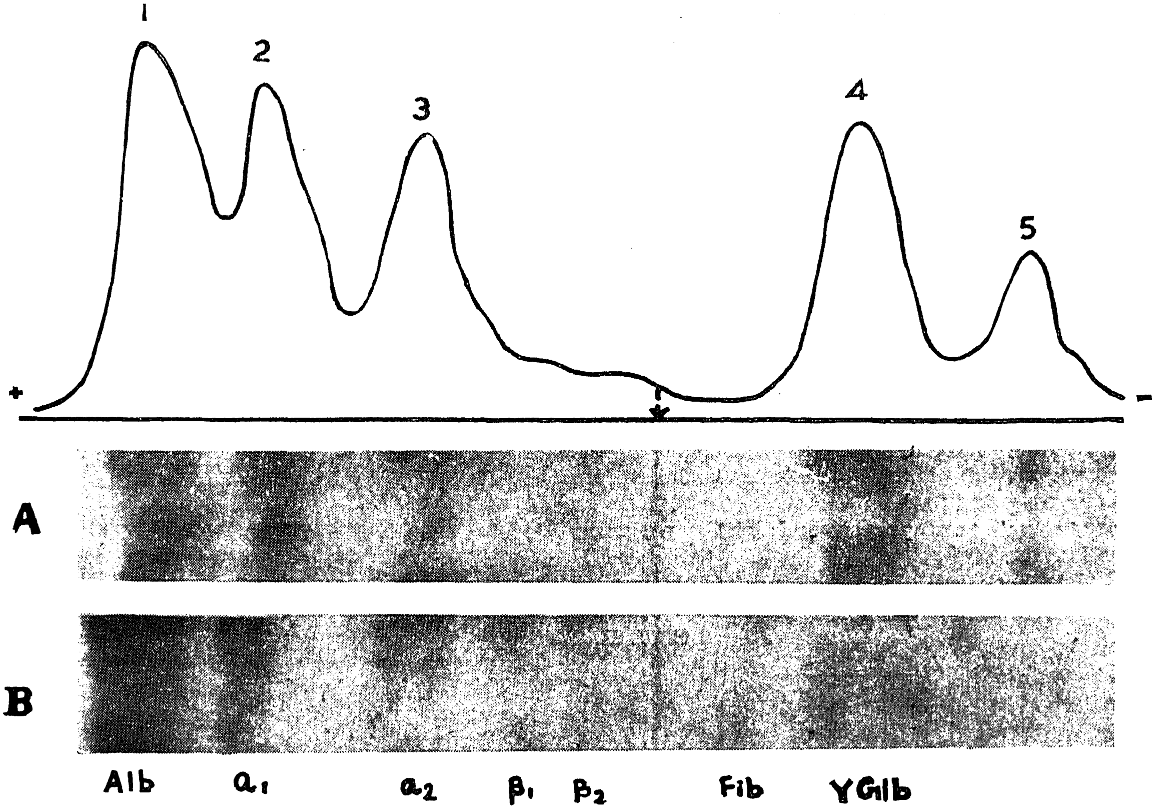

FIG. 1. Electrophoretic pattern of the blood proteins of *Scolopendra morsitans* (A), Compared with that of human plasma (B).

Proteins 1 to 3 exhibit anodic mobility similar to serum albumin and a_1 and a_2 globulins, respectively. Protein 4 corresponds to the γ-globulin. Protein 5 does not have any corresponding member in human serum and there is no protein in centipede blood that corresponds to fibrinogen (Fig. 1).

It may be noted that the blood protein pattern of *Scolopendra morsitans* differs markedly from that of millipedes,[1] the most significant difference being the absence of fibrinogen in the centipede blood. It is suggestive that this feature may be responsible for the absence of coagulation of blood in the centipedes.

I wish to thank Professor G. Krishnan, for his interest in this work. Thanks are also due to Dr. S. Natarajan of Stanley Hospital for the gift of human plasma.

Dept. of Zoology, G. SUNDARA RAJULU.
University of Madras,
Madras-5, *June* 10, 1969.

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REVIEWS AND NOTICES OF BOOKS

First Principles of Numerical Analysis. By Burton Wendroff. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. 118. Price 61 *sh.*

Subject-matter in this book has been divided into four logical parts. The first part, Chapter 1, is an introduction to digital computers. The second part, Chapters 2 and 3, presents numerical methods based on Taylor's theorem. The third part, Chapters 4, 5 and 6, presents corresponding numerical methods derived from interpolation. The last part, Chapter 7, discusses the solution of linear systems.

Two years of university mathematics is a necessary prerequisite for a study of this book. Some of the exercises ask the student to write a program. Rather than requiring a programming language as a prerequisite, the course may be planned to include one laboratory hour a week in which the student would learn programming and prepare and run the programs called for.

This book will be found useful by applied mathematicians, engineers, and scientists.

C. V. R.

Catalysis Reviews (Book Edition) (Vol. 2). Edited by H. Heinemann. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1969. Pp. vii + 359. Price $17.50.

This series, *Catalysis Reviews,* emphasizes the interdisciplinary aspects of catalysis. It is dedicated to the belief that the science of catalysis can best be advanced by avoiding compartmentalization and by critically examining phenomena and observations at the periphery as well as the center of the field. The series is not limited to only homogeneous and heterogeneous catalysis. It reviews advances in technology as well as theory, is concerned with both engineering and chemical aspects of catalytic reactions, with reactor design, computer models, analytical tools, and statistical evaluations, to name only a few subjects.

Reviews contained in these volumes concern solid state physics and chemistry, electrochemistry, metallurgy, corrosion, polymerization, biochemistry, and other fields which add to knowledge of catalytic phenomena by analogy or deduction.

Volume 2 of this series under review contains the following articles: The Band Picture in the Electronic Theories of Chemisorption on Semiconductors, by F. Garcia-Moliner; Kinetics Analysis by Digital Parameter Estimation, by Y. Bard and L. Lapidus; The Surface Properties of Zeolites as Studied by Infrared Spectroscopy, by D. J. C. Yates; Application on Mossbauer Spectroscopy to the Study of Adsorption and Catalysis, by W. Nicholas Delgass and Michel Boudart; Corrosion of Platinum Metals and Chemisorption, by J. Llopis; Inhibition Processes in the Gas Phase, by Z. G. Szabo; Determination of Heat of Adsorption on Clean Solid Surfaces, by Slavoj Cerny and Vladimir Ponec; Prediction of Catalytic Action as Presented in Papers Before the Fourth International Congress on Catalysis, by V. B. Kazansky; and United States-Japan Conference on Catalysis, by John Turkevich.

C. V. R.

Introduction to Complex Analysis. By Nevanlinna/Paatero. (Addisons-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. ix + 348. Price 74 *sh.*

This book is based upon lectures given by the authors at Helsinki University and at the University of Zurich, and is a translation of the German edition, *Einfuhrung in die Funktionentheorie,* published by Birkhauser Verlag, Basel, in 1964.

Designed for mathematics majors at junior, senior, or graduate levels, this will serve as a first course in complex analysis. The only prerequisite is advanced calculus.

In providing a basic, high-level introduction to complex function theory, the book uses the approach of the Finnish school—principally geometric and intuitive. A set of exercises follows each chapter.

The contents of this book are: The Concept of an Analytic Function; General Properties of Rational Functions; Linear Transformations; Mapping by Rational Functions of Second Order; The Exponential Function and Its Inverse. The General Power; The Trigonometric Functions ;; Infinite Series with Complex Terms; Integration in the Complex Domain. Cauchy's Theorem; Cauchy's Integral Formula and Its Applications; The Residue

Theorem and Its Applications; Harmonic Functions; Analytic Continuation; Entire Functions; Periodic Functions; The Euler Γ-Function; The Riemann ζ-Function; and The Theory of Conformal Mapping. C. V. R.

Theoretical and Experimental Biophysics (Vol. 2). Edited by Arthur Cole. (Marcel Dekker, Inc., 95, Madison Avenue, New York, U.S.A.), 1969. Pp. xiii + 343. Price $ 17.75 or £ 8. 3 *sh.* 0 *d.*

The purpose of this series is to provide a collection of topics which typify the increasing utilization of the concepts and tools of chemistry, physics, and mathematics in the study and description of biological phenomena. In general, the authors have attempted to present their subject so that it will be of interest to both the specialist and the novice.

The contents of this volume are: Biological Membranes, by Edward D. Korn; Chemical-Relaxation Methods, by George H. Czerlinski; Chemiosmotic Coupling and Energy Transduction, by Peter Mitchell; Time-Lapse Microcinematography in Cell Biology, by Andrew Bajer; and The Structure and Arrangement of Viral Nucleic Acids, by Heather D. Mayor.

The book will be found useful by scientists and students interested in biological phenomena.

C. V. R.

Nippostrongylus and Toxoplasma. Edited by Angela E. R. Taylor. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX 1 4HB, England. Available from Current Technical Literature Company Private Ltd., Bombay). Pp. 75. Price 30 *sh.*

This volume contains the papers presented at the seventh symposium of the British Society for Parasitology, held at the Zoological Society of London in November 1968. The three papers on *Nippistrongylus brasiliensis* are: (1) Some Aspects of the Fine Structure and Biology of the Infective Larva and the Adult, by D. L. Lee; (2) Biochemistry of *N. brasiliensis* and other nematodes, by C. D. Ginger; and (3) Immunity to *N. brasiliensis*, by B. M. Ogilvie. The reports on Toxoplasmosis are: (1) The Biology of *Toxoplasma* Infections, by J. K. A. Beverley; (2) Transmissible Toxoplasms by W. M. Hutchinson, J. F. Dunachie and K. Work; and (3) The Dissemination of Protozoa and other Micro-organisms by Helminths, by A. M. Woodruff. A. S. G.

Methods for Chemical Analysis of Fresh-Waters. By H. L. Golterman. (IBP Handbook No. 8). (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX 1, 4 HB, England). Pp. 172. Price 30 *sh.*

The International Biological Programme handbooks are chiefly intended for those who are participating in this world-wide plan of co-ordinated research concerned with 'the biological basis of productivity and human welfare". Their purpose is to recommend the use of research methods which will give intercomparable results from any part of the world.

The present manual is meant as a guide to chemical methods for research workers interested in those biological processes in freshwater, that lead, with interconversion of energy, to the production of organic material. The environment is important for many of these processes and the methods in this manual may help to describe it. Sufficient detail and explanation have been included so that the handbook can be used by those with little background training in either chemistry or limnology. A. S. G.

Books Received

Characterization of Organic Compounds by Chemical Methods—An Introductory Laboratory Text-Book. By Terence C. Owen. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1969. Pp. vii + 267. Price $ 6.75.

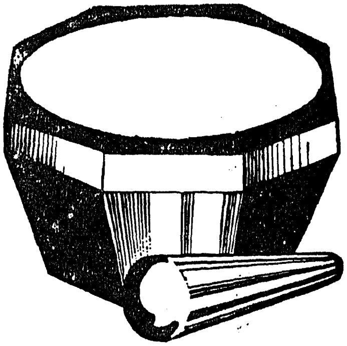
An Introduction to Matrices and Linear Transformations. By John H. Staib. (Addison Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1), 1969. Pp. xii + 336. Price 59 *sh.*

Late Seventeenth Century Scientists. Edited by Donald Hutchings (The Pergamon Press Ltd., Hedington Hills Hall, Oxford), 1969. Pp. xi + 183. Price 40 *sh.*

International Biological Programme Hand-Book No. 8—Methods for Chemical Analysis of Freshwaters. Edited by H. L. Golterman and R. S. Clymo. (Blackwell Scientific Publications, 5, Alfred Street, Oxford OX 1 4 HB, England), 1969. Pp. xvi + 172. Price 30 *sh.*

Structure and Stability of Biological Macromolecules. Edited by S. N. Timasheff and G. D. Fasman. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1969. Pp. ix + 694. Price $ 33.50.

1450-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.



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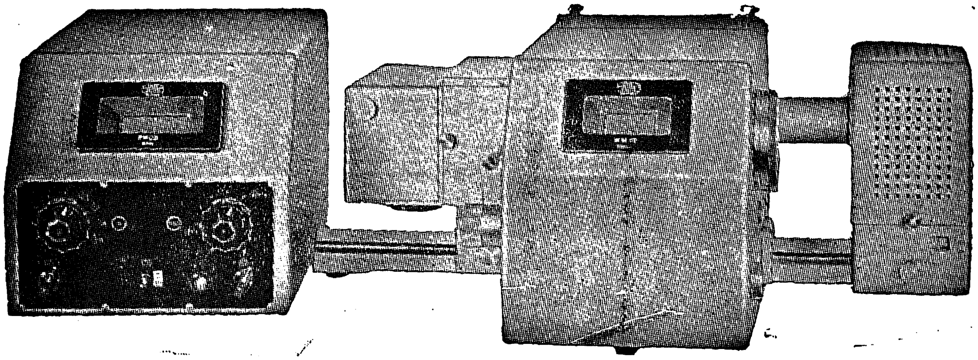

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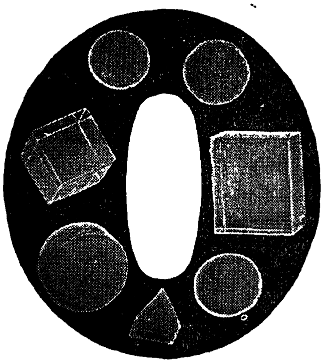

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ON THE INTERNAL AND EXTERNAL OXIDATION OF Cu-1% Zr, Cu-0·5% Ti AND Cu-1% Ti ALLOYS

K. I. VASU

Materials Research Group, Department of Metallurgy, Indian Institute of Science, Bangalore-12

ABSTRACT

Oxidation of Cu-1% Zr, Cu-0·5% Ti and Cu-1% Ti alloys in pure oxygen in the range of 600° to 900° C. is generally governed by a linear rate law in the initial stage (which is very conspicuous with Cu-1% Zr alloy) and a parabolic rate law in the succeeding stage. The linear oxidation has a low activation energy of 9 Kcal./mole and involves a phase-boundary process of chemisorption. The parabolic oxidation, controlled by the Cu^+ ion diffusion through the scaling layer, has a high activation energy of 30 Kcal./mole.

INTRODUCTION

COPPER and copper-base alloys are extensively used for a variety of pusposes. Cu-Al alloys containing small amounts of aluminum have been found to possess excellent resistance to high-temperature oxidation, while minor addition of many metals improve the properties of pure copper. Our studies on copper-manganese[1] and copper-magnesia composite alloys[2] have been reported earlier. This paper deals with some of the preliminary studies on the oxidation of Cu-1% Zr, Cu-0·5% Ti and Cu-1% Ti (wt. % indicated) alloys. Titanium and zirconium were selected as the alloying addition because of the possibility of internal oxidation and the consequent dispersion-strengthening with significant improvement in the mechanical properties of these alloys. Pure copper and many of its alloys do not possess sufficient strength and oxidation resistance at slightly elevated temperatures, while the dispersion-strengthened alloys of the metal-oxide type are characterised by high-temperature stability as expressed by excellent stress-to-rupture strength and creep resistance at elevated temperatures.[3]

The nature of oxidation of pure copper under a variety of conditions has been studied extensively.[4-8] The mechanism of alloy oxidation is quite complex and is controlled not only by the characteristics of the constituent metals but also by the nature of the oxides formed, their structure and solid solubility, the stability of the oxides in presence of the parent metal and the impurity elements, the transport processes in mixed oxides and alloy phases, oxide plasticity and creep, mechanical stresses in growing oxide scales, and the possibility of internal oxidation of one of the alloying constituents such as titanium or zirconium. Under the experimental conditions copper can form CuO at high oxygen pressures, and Cu_2O in presence of copper or at low oxygen pressures, while Ti and Zr form the respective dioxides, which are highly stable and refractory. Little is known about their mutual solid solubility.

EXPERIMENTAL

Alloy Preparation.—Electrolytic Cu (99·95%) and high-purity Ti (99·9%) and Zr (99·9%) are used for the alloy preparation. A capsule was made out of copper rods by drilling a hole at the centre and having a tight-fitting copper plug. The necessary amount of titanium or zirconium was placed inside the capsule and it was plugged air-tight. This was induction-melted in alumina crucibles under a cover of borax and cast in the form of rods. After a slight cold working, these were packed in graphite powder and homogenized at 800° C. for 24 hours. Analysis showed that the alloys contained 0·49% Ti, 0·98% Ti and 0·99% Zr and were designated as Cu–0·5 Ti, Cu-1 Ti and Cu-1 Zr alloys. Photomicrographs showed a homogeneous, fine-grained structure without any carbon pick-up or oxide inclusion.

External Oxidation.—The rate of oxidation in pure oxygen was followed by noting continuously the increase in weight with time of a polished alloy disc suspended from a precision balance in such a way that it occupies the even hot zone of a movable furnace arranged beneath the balance. Details of the thermobalance assembly, the procedure adopted and the precautions taken have been given elsewhere.[1,2] This method ensures continuous weight-increase measurements from the very beginning of oxidation. Upon conclusion of the oxidation, the specimens were examined metallographically by standard metallurgical techniques.

Internal Oxidation and Property Measurements.—The specimens for tensile tests and hardness were cut from sheets obtained by rolling the specimens. These specimens were internally oxidized by the Rhines-Pack method.[9] The samples were packed in a mixture of equal parts of cuprous oxide and copper powder enclosed in a silica tube and 'oxidized' at 850° C. in an atmosphere of purified nitrogen for 12 hours or 24 hours.

The tensile tests were carried out on a modified[10] Hounsfield tensometer at a strain rate of 0·005 inch per inch per minute on a one inch gauge length at room temperature.

The specimens after oxidation were mounted, sectioned transversely and examined metallographically. Hardness was measured from periphery to centre of the specimen, on a Leitz Microhardness Tester using a load of 100 g.

RESULTS

The rate of oxidation is generally[4-6] represented by an equation of the type:

$$\Delta w = k t^{n} + C$$

where Δw is the weight gain per unit area at time t, k is the rate constant, C is another constant (which may be zero in some cases) and the value of the exponent, n, determines the type of the operating mechanism and the corresponding rate law. Figure 1 shows the plot of log (Δw) *versus* log t for Cu-1 Zr alloy. There is a distinct break in the curves, indicating that the operating mechanisms are different in the initial and the later stages of oxidation. The slope, equal to n, is 1 for the initial region and here a linear rate law, $\Delta w = k_l\ t + C$, is operating, where k_l is the linear rate constant. The slope for the final stages of oxidation is 0·5 and here a parabolic rate law, $\Delta w^2 = k_p t + C'$ is operating k_p is the parabolic rate constant. For the Cu-Ti alloys, a parabolic rate law is more or less applicable right from the beginning of oxidation, except for a very short period of linear oxidation which could not be resolved in this series of experiments. All the rate constants obey an Arrhenius-type relation $[k = A \exp. (-E/RT)]$ for the temperature dependence. The activation energy, E, was calculated in each case to identify the rate-controlling mechanism of oxidation.

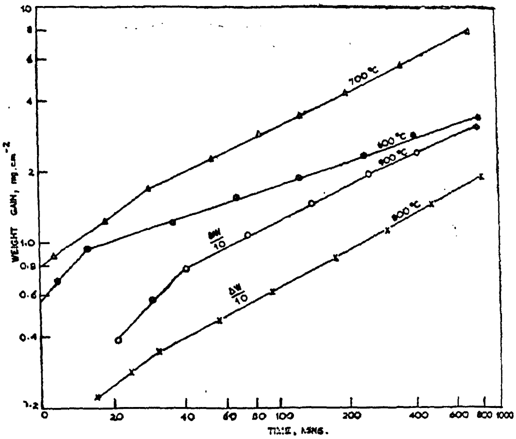

FIG. 1. Nature of oxidation of Cu-1% Zr alloy.

The values of the rate constants and the activation energies are collected in Table I.

DISCUSSION

The first stage of oxidation involves a predominant chemisorption and dissolution of oxygen and finally an oxide nucleation. Since the oxidation rate is linear for Cu-1 Zr alloy, a surface or phase-boundary process is rate-controlling. This may involve, for example, a steady-state reaction limited by the supply of chemisorbed oxygen at the oxide surface, or a reaction governed by a steady-state formation of oxide at the metal-oxide interface. Chemisorption on CuO or Cu_2O generally requires only low activation energy,[11] and since the activation energy for the linear oxidation is only 9·2 Kcal./mole, it is presumed that the chemisorption of oxygen at the oxide-gas phase-boundary is the rate-determining process in the initial oxidation of Cu-1 Zr alloy.

There are striking similarities between the kinetics of activated adsorption on metals and the kinetics of thin oxide film formation on metals. Landsberg[12] derived a logarithmic relation for adsorption by assuming that each adsorbed atom generates fewer adsorption sites than it invalidates. Jones and Westerman[13] extended this concept to the initial logarithmic oxidation of metals. We have observed such a situation in the initial oxidation of nickel-zirconia composite alloys.[14] However, Hurlen[15] who studied the oxidation of titanium states that in thin film formation an equilibrium situation will be rapidly

TABLE I

Oxidation data on Cu-Ti and Cu-Zr alloys

Alloy	Rate law and rate constant	Temperature °C. 600	700	800	900	Activation energy Kcal. mole^{-1}
Cu-1 Ti ..	Parabolic, $k_p \times 10^3$ (mg.^{2}.cm.$^{-4}$.sec.$^{-1}$)	0·175	1·66	7·67	24·0	30·0
Cu-0·5 Ti ..	Parabolic, $k_p \times 10^3$ (mg.^{2}.cm.$^{-4}$.sec.$^{-1}$)	0·163	1·67	8·.3	26·6	32·0
Cu-1 Zr ..	Final parabolic, $k_p \times 10^3$ (mg.^{2}.cm.$^{-4}$sec.$^{-1}$)	0·238	1·70	8·43	28·1	28·5
Cu-1 Zr ..	Initial linear $k_l \times 10^3$ (mg..cm.$^{-2}$.sec.$^{-1}$)	8·30	14·0	25·0	33·0	9·2

reached where the rates of site generation and invalidation are equal ; this would lead to a linear oxidation rate. It is this situation that we observe in the initial oxidation of Cu-1 Zr alloy. The slightest deviation on either side of the equilibrium situation results in failure of the linear rate law. If oxide molecules invalidate more sites than are generated, a logarithmic law results, as was shown earlier. If more sites are generated than invalidated, adsorption becomes very rapid, and another mechanism, such as diffusion through the oxide film, controls the oxidation. Wagner's mechanism[4-6] of parabolic oxidation is based on the diffusion process.

Continued oxidation is possible by a counter-current diffusion of metal and oxygen atoms (or ions and electrons) through grains or along grain boundaries of the intermediate oxide layer at the metal-gas interface. The electrical and the physical-mechanical properties of this oxide layer determine the mechanism of oxidation. As a rule, parabolic oxidation signifies that a diffusion process is rate-controlling, and the activation energy for oxidation may then turn out to be that for the diffusion step. The temperature dependence of the constants for parabolic oxidation of Cu-0·5 Ti, Cu-1 Ti and Cu-1 Zr (later stages) alloys gives approximately 30 Kcal./mole as the activation energy (Table I). This is slightly lower than that for pure copper (38 ± 2 Kcal.) or for the diffusion of Cu^+ ions through a Cu_2O layer (37 Kcal.). However, this indicates that a preferred Cu^+ ion diffusion is the operating mechanism of parabolic oxidation. The decrease in the activation energy on alloying copper with Ti and Zr implies an increased ease of diffusion in the mixed oxide scale. Cu_2O is a *p*-type semiconductor and incorporation of higher-valency ions (Ti^{4+} or Zr^{4+}) during the oxidation of Cu-(Ti, Zr) alloys would result in an increase in the cation (Cu^+) defects ; the rate and the ease of diffusion of cations would thus increase and so would the rate of oxidation, since it is a process essentially controlled by cation diffusion as discussed earlier. This may not apply to the continued oxidation of alloys containing larger amounts of Ti or Zr.

Photomicrographs of the oxidized specimens revealed that the oxidation involves the formation of Cu_2O (*plus* an outer skin of CuO) and a subscale oxidation zone near the periphery of the alloy. This internal oxidation zone is due primarily to the solubility of oxygen in the alloy phase and the selective oxidation of Ti or Zr due to the large difference between the free energy of formation of Cu_2O and the oxides of Ti or Zr. Internal oxidation and the resulting fine oxide particles of zirconium or titanium dispersed in the copper matrix strengthens the material, giving a higher hardness in the periphery compared with the interior. This was further confirmed by the internal oxidation of Cu-0·5 Ti alloy by the Rhines-Pack method[9] at 850° C. and determining the strength of the material. The stress-strain diagram given in Fig. 2 reveals that the

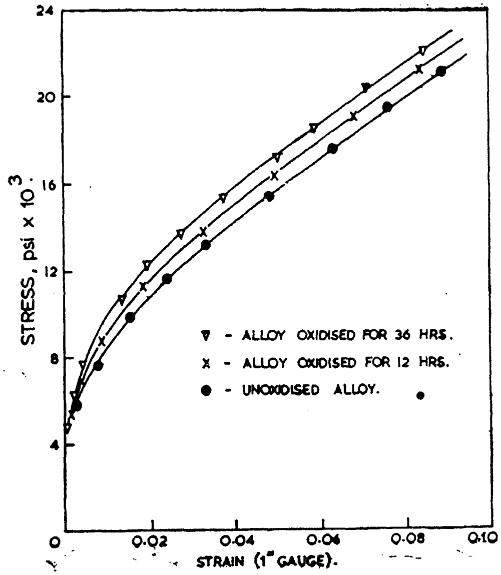

FIG. 2. Strengthening of Cu-0·5% Ti alloy due to internal oxidation at 850° C. by the Rhines-Pack method.

strength increases considerably as a result of internal oxidation. The incoherency due to the presence of dispersed oxide particles strengthens the otherwise soft matrix, and this type of composite alloys may prove to be useful for high temperature applications.

ACKNOWLEDGEMENTS

The author is thankful to Mr. V. Sivan and Mr. N. Rajamanikkan for their assistance in the work, to Dr. S. Dhawan, Director, Indian Institute of Science, and Prof. A. A. Krishnan for their interest in the work, and to the members of the Materials Research Group for their active co-operation.

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SENSITIZATION IN CaS : Zr, Mn PHOSPHORS

D. R. BHAWALKAR AND K. MULEY
Solid State Physics Laboratory, Department of Physics, University of Saugar, Saugar

ABSTRACT

CaS : Zr, Mn phosphor system was found to present an interesting case of sensitized luminescence and hence was investigated in detail. Absorption, excitation and emission spectra along with thermoluminescence and decay characteristics were studied. The results indicate resonance transfer of excitation energy from Zr to Mn. Sensitizer-sensitizer transfer also appears to be appreciable. The trap-depths calculated from thermoluminescence and decay studies show good correlation, thus justifying the use of the simple theory of Randall and Wilkins which neglects retrapping. Perturbed levels of the lattice lying quite close to luminescence centres appear to act as traps. A plausible energy level diagram is proposed to explain the luminescence mechanism.

INTRODUCTION

SENSITIZATION is transfer of excitation energy from one luminescence centre to another. It was first investigated by Tomaschek[1] and Rothschild[2] in alkaline earth sulphides. Numerous studies were made afterwards but a majority of them have been on non-photoconducting phosphors. For photoconducting phosphors, the work has recently started and considerable work has been done on alkali halides too. However, in alkaline earth sulphides, this phenomenon has not been sufficiently studied.

Divalent Mn is known to give rise to appreciable luminescence only by sensitization when incorporated in inorganic phosphors. It has been reported to give orange red luminescence in CaS lattice when excited in the host crystal absorption band.[3,4] Since the transition involved is a forbidden one, luminescence appears only with the host excitation. It is found that this Mn emission is sensitized by zirconium. Zr when introduced in the CaS lattice creates its own absorption band on the long wavelength side of the host absorption, and excitation in this band gives rise to its

TABLE I

Phosphor	Absorption band peaks eV	Region of strong absorption eV	Excitation band peaks eV (for 2·24 eV emission)	Remarks
†CaS	5·16, 4·65, 3·98	5·10–4·25	5·10*, 4·60, 3·91*, 3·61*, 3·16*	Increase in Zr concentration in general increases the absorption. With increase in Zr concentration weak 4·25 eV band is strengthened, additional 4·40 eV band is developed, 3·52 eV band increases in strength as well as in extension and 2·90 eV band, while increasing in strength, shifts to 2·71 eV. Gradual addition of Mn to CaS : Zr phosphors decreases the absorption, 5·36 eV shifts to 5·43 eV. In CaS : Mn phosphors with increase in Mn concentration 5·16 shifts to 5·43 and additional weak bands at 3·61 and 3·24 eV are developed. 4·60 eV excitation band is the strongest one
CaS : Zr (0·12%)	5·16, 4·57, 4·25* 3·52*, 3·33*, 2·90	5·10–3·98	5·10, 4·60, 4·40, 3·85, 3·61, 3·28, 3·16	
CaS : Zr (0·95%)	5·36, 4·65, 4·40, 4·25, 3·61, 2·71, 2·05	5·10–3·42	5·10, 4·60, 4·40, 3·85, 3·61, 3·28, 3·16	
CaS : Zr (0·95%) Mn (0·02%)	5·36, 4·60, 4·25, 3·61, 2·71, 2·05	5·10–3·42	5·10, 4·60, 4·40, 3·85, 3·61, 3·16	
CaS : Zr (0·95%) Mn (2·3%)	5·43, 4·53, 4·25, 3·61*, 2·05	5·10–3·85	5·10, 4·60, 4·40, 3·85*, 3·61*, 3·30*, 3·16*	
†CaS : Mn (1·2%)	5·32, 4·65, 4·04*	5·10–3·98	5·10, 4·60, 3·91*, 3·61*, 3·16*	
†CaS : Mn (9%)	5·43, 4·57, 3·61* 3·24*	5·10–3·98	5·10, 4·60, 4·00*, 3·83*, 3·61*, 3·16*	

* Weak. † Absorption in the visible region not studied.

own luminescence. However, when Mn is present along with Zr, transfer of excitation energy takes place and Mn emission is obtained. With a view to studying this energy transfer, absorption, excitation and emission spectra of CaS : Zr, CaS : Zr, Mn and CaS : Mn phosphors were studied. To have an idea about the nature and distribution of trapping states in these phosphors, phosphorescence decay and thermoluminescence measurements were also made. This article presents a summary of the results of these studies. The phosphors (in all about 40) were prepared by the method developed in this laboratory and all the studies were made at room temperature.

RESULTS AND INTERPRETATION

(*a*) *Absorption and Excitation.*—Table I summarizes the results of absorption and excitation of a few representative samples. 5·43–5·16 eV absorption is attributed to host lattice, 4·40 eV to Zr levels perturbed by the host lattice and 4·25 eV to Zr ions embedded in the CaS lattice. Strong absorption starting from 5·1 eV is attributed to the first exciton excitation of the crystal and 4·65–4·53 eV to the levels of the host lattice perturbed by the incorporation of flux. Studies of Levshin and co-workers and Tomar[4,5] also support these views. 3·51, 3·61 eV absorption appears to be due to the defect centres (Ca^{2+} vacancies or other localized levels) produced so as to effect charge compensation. 2·90–2·71 eV absorption is attributed to aggregates of defect centres, 2·05 eV to some localized levels introduced by Zr at high concentration and 3·61 eV observed at high Mn concentration to electron transition in MnS lattice perturbed by the surrounding Ca ions. The excitation bands do not exactly coincide with the absorption bands but nevertheless lie in the region of strong absorption.

(*b*) *Emission, Sensitization and Transfer of Energy.*—Table II summarizes the results of emission. 3·33 eV emission is attributed to some unknown impurity, 2·80 eV along with 2·05 eV to Zr impurity, 1·86 eV to Mn^{2+} centres and 2·12 eV to defect centres. In CaS : Zr, Mn phosphors, with 240·7, 265·5 and 281·4 mμ excitations, the Zr emission is gradually replaced by Mn emission as the Mn concentration increases. It therefore appears that the energy is transferred to Mn^{2+} centres. With 319·1, 338·5, 380·6 and 391·1 mμ excitations, with increase in Mn concentration, though 2·74–2·47 eV region and also the 2·24 eV emission get quenched, this energy does not appear on the long wavelength side, *i.e.*, transfer from defect centres to Mn^{2+} ones is not a probable one.

With 240·7, 265·5 and 281·4 mμ excitations, the emission produced is similar and is the emission attributed to Zr impurity. It is therefore proposed that the transitions corresponding to these excitations occur to some

TABLE II

Phosphor	Exciting wavelength mμ	Emission band peaks eV	Remarks
CaS	240·7	3·33, 2·80, 1·86	Very weak fluorescence. Except 265·5 mμ, emission excited by all other wavelengths is very, very poor in intensity. 3·33 and 2·80 eV bands are very weak compared to 1·86 eV band
	265·5	3·33, 2·80, 1·90	
	313	2·80, 2·09	
	338·5	2·80, 2·12	
	391·1	2·09	
CaS : Mn (0·02%)	240·7	3·33, 2·80, 1·86	CaS : Mn phosphors are weak ones. With increasing Mn concentration, luminescence intensity decreases. 240·7 and 265·5 mμ lines excite similar emission but that excited by 319·1, 338·5 and 391·1 mμ lines is different. 3·33 and 2·80 eV bands in the emission excited by 240·7 and 265·5 mμ lines are very weak compared to 1·86 eV band
	265·5	3·37, 2·80, 1·86	
	319·1	3·37, 2·80, 2·09	
	338·5	2·80, 2·09	
	391·1	2·09	
CaS : Mn (9%)	240·7	3·33, 2·80, 1·86	
	265·5	3·37, 2·80, 1·86	
	319·1	3·33, 2·80, 2·12	
	338·5	2·80, 2·12	
	391·1	2·11	
CaS : Zr (0·12%)	240·7	3·33, 2·80, 2·05	CaS : Zr phosphors are quite strong ones. 240·7, 265·5 and 281·4 mμ lines give similar emission, the 2·80 eV band being not resolved at low Zr concentration with 265·5 and 281·4 mμ excitations. 319·1, 338·5 and 391·1 mμ excitations give similar emission which is different from that excited by 240·7, 265·5 and 281·4 mμ excitations
	265·5	3·33, 2·05	
	281·4	3·33, 2·05	
	319·1	3·33, 2·12	
	338·5	2·80, 2·12	
	391·1	2·12	
CaS : Zr (0·95%)	240·7	3·33, 2·80, 2·05	
	265·5	3·33, 2·80, 2·05	
	281·4	3·33, 2·80*, 2·05	
	319·1	2·80 2·24*, 2·12	
	338·5	2·80, 2·24*, 2·12	
	391·1	2·24, 2·12	
CaS : Zr (0·95%) Mn (0·02%)	240·7	3·33, 2·80, 1·92	Gradual addition of Mn to CaS : Zr phosphors produces the following effects : (1) Reduction in intensity of the 2·80 eV band (for 265·5 and 281·4 mμ excitations) (2) Quenching of emission lying between 2·74 and 2·47 eV (for all excitations) (3) Gradual shifting of the peak from 2·05 to 1·86 eV (for 240·7, 265·5 and 281·4 mμ excitations) (4) Disappearance of the indicated 2·24 eV band (for 319·1, 338·5 and 391·1 mμ excitations)
	265·5	2·80, 1·96	
	281·4	3·33, 2·80 1·96	
	319·1	2·80, 2·24* 2·12	
	338·5	2·80, 2·12	
	391·1	2·12	
CaS : Zr (0·95%) Mn (2·3%)	240·7	2·80, 1·86	
	265·5	3·33, 2·80 1·86	
	281·4	2·80, 1·86	
	319·1	2·80, 2·12	
	338·5	2·80, 2·12	
	391·1	2·12	

* Indication only. Not clearly resolved.

It has been found that 240·7, 265·5 and 281·4 mμ excitations give strong fluorescence and a very weak phosphorescence, whereas reverse is the case with 319·1, 338·5 and 391·1 mμ excitations.

localized level below the conduction band, the holes left thus migrate to Zr centres, thereby producing the Zr emission. The probability of transfer of excitation energy from this level to Mn^{2+} centres is quite high. The present data are not sufficient to decide between the two mechanisms, *viz.*, the resonance transfer and the movement of charged carriers. However, the reported fact that appreciable photoconductivity is observed in CaS : Cu phosphors when light is absorbed in the defect centres absorption band superimposed on the long wavelength tail which give rise to strong phosphorescence[3] and our observation that 319·1, 338·5, 380·6 and 391·1 mμ excitations give strong phosphorescence, suggest resonance transfer to be the predominant mechanism of energy transfer. Mn emission is found to increase with increase in Zr concentration and this suggests appreciable sensitizer-sensitizer transfer. Approximate position of Mn absorption lies between 450–500 mμ. Excitation by 466 mμ line of mercury gives not the Mn emission but an emission similar to that obtained when phosphors are excited in the aggregates of defect centres absorption band. This suggests that the exchange interactions between defect centres and Mn ions are not possible.

(c) *Decay.*—The results of decay studies indicate a hyperbolic decay which can be represented by an equation of the type $\mathrm{I}_t = \mathrm{I}_0\, t^{-b}$ where b is the decay constant. It was possible to break up the decay curve into three exponentials and the trap-depths corresponding to these were calculated. Only one group of traps was found to be effective. The trap-depths appear to decrease with increasing Mn concentration, but do not vary significantly with Zr concentration.

(d) *Thermoluminescence.*—With 0·05° K/sec. heating rate, the glow intensity was quite low and the curves showed only one broad peak which did not show any appreciable variation with increase in Mn concentration. With 0·2° K/sec., the glow curves are quite broad and nearly all the samples, except those with high Mn concentration, showed the presence of two peaks. With 0·61° K/sec. heating rate, glow intensity obtained is quite high and the glow curves have a single comparatively sharp peak. With the latter two heating rates, the peak temperature shifts to high temperature side and the intensity of thermoluminescence emission becomes weak as Mn concentration increases. It was not possible to detect glow emission, if any, for phosphors having Mn concentration greater than 0·2%. The trap-depths were calculated by the formula given by Curie.[6] They were found to be slightly higher than those found from decay. This is expected, since phosphors were allowed to decay to a very low intensity before the heating was started. The trap-depths, however, appear to increase with increase in Mn concentration which is in contrast to the results obtained from decay and can be explained by taking into consideration,

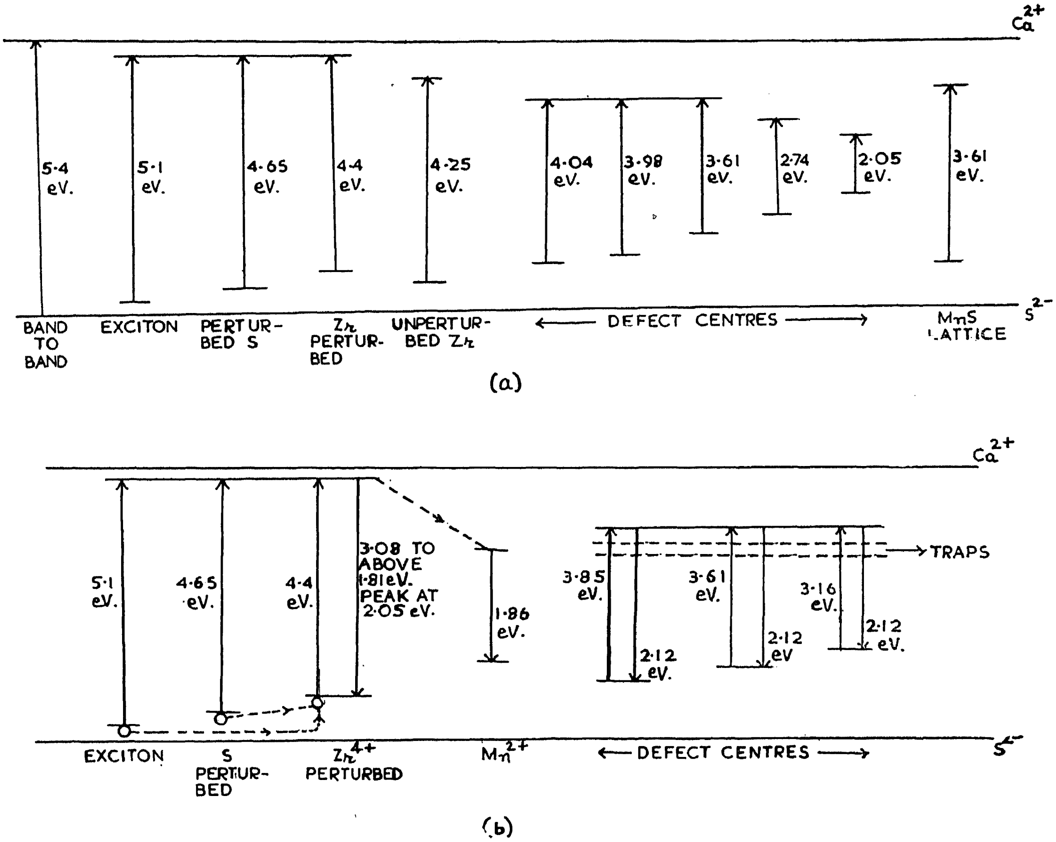

FIG. 1 *a*, *b*. Energy level diagram for the CaS : Zr, Mn phosphor system. Readjustment of levels during emission not shown in the figure.

the different decay rates of the two emission bands, the quenching of 2·74–2·47 eV emission with increase in Mn concentration and the maximum sensitivity of the detector phototube in the blue region. However, the trap-depths calculated with the low heating rate were found to agree quite well with those corresponding to the slowest exponential in phosphorescence decay, thus justifying the use of Randall and Wilkins'[7] theory of phosphorescence decay in CaS : Zr, Mn phosphors.

Zr by itself has been reported to introduce no new trapping states. In phosphors containing high Mn concentration, traps due to Mn will predominate, but no thermoluminescence is observed in the temperature range studied for phosphors with high Mn concentration. The glow peaks attributed to traps formed by Mn in different phosphor systems have been reported to be below room temperature only. Most of the investigations in this laboratory on CaS phosphors activated with different activators and prepared with different fluxes revealed a group of traps lying between 0·6 and 0·8 eV. We may therefore say that the traps observed in the present system are typical of the host lattice itself.

Our experimental results of decay and thermoluminescence studies are quite well explained by the simple theory of Randall and Wilkins which neglects retrappin bined with the observation that are photoconducting when defect centres absorption bands to long-lasting phosphorescence the traps are the perturbed lattice lying quite close to centres. Their size has been of the order of 10^{-17} cm.^{2}[8]

The above-shown energy (Fig. 1, *a* and *b*) has been CaS : Zr, Mn phosphor system.

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ON THE OCCURRENCE OF THE DEEP-WATER SQUALOID SHARK *SQUALUS FERNANDINUS* MOLINA FROM THE CONTINENTAL SLOPE THE WEST COAST OF INDIA*

E. G. SILAS‡ AND N. K. PRASAD‡

Central Marine Fisheries Research Institute, Mandapam Camp, S. India

ABSTRACT

During exploratory trawling from the upper continental slope in depths between 29 and 325 metres off the south-west coast of India, a specimen of the Squaloid shark *fernandinus* Molina was obtained. This species is a new distributional record for Indian and it is described and illustrated.

On 7-8-1969 the Indo-Norwegian Project Fishing Vessel M.V. *Velameen* while trawling on the upper continental slope off Quilon between 290 and 325 metres obtained one specimen of a species of squaloid shark which is identified here as *Squalus* Molina. Up to now no representative genus *Squalus* Linnaeus popularly the 'Spiny dogfish' has been reported Indian Seas. In view of the fact that of *Squalus* are of considerable econ portance in some areas constituting fishery, the present record is of special A description of this new record a taxonomic discussion is given below

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[‡] Present address: Central Marine Fisheries Research Substation, Gopala Prabhu Cross Road, Ernakulam Cochin-11.

Squalus fernandinus Molina, 1782
(Fig. 1, *a–k*)

Material.—One male, 495 mm. in total length, weighing 480 gm., trawled between 290 and 325 metres off Quilon by M. V. *Velameen* on 7-8-1969.

Synonyms.—For a detailed list of synonyms reference is invited to Bigelow and Schroeder (1948, 1957).

Description.—Proportional dimensions in per cent of total length of the specimen is as follows :

Trunk at origin of pectoral: breadth 12·9, height 9·5 ; *Snout length in front of*: outer nostrils 4·0, mouth 9·1 ; *Inter-orbital distance*: 8·3 ; *Eye*: horizontal diameter 4·9 ; *Mouth*: breadth 7·9, height 1·2 ; *Nostrils*: distance between inner ends 4·6 ; *Labial furrow length from angle of mouth*: upper 2·8, lower 2·4 ; *Gill opening lengths*: 1st 2·8, 2nd 3·2, 3rd 3·4, 4th 3·4, 5th 3·2 ; *First dorsal fin*: vertical height 7·1, length of base 7·3 ; *Second dorsal fin*: vertical height 3·8, length of base 5·5 ; *Caudal fin*: upper margin 21·8, lower anterior margin 11·7 ; *Pectoral fin*: outer margin 13·1, inner margin 7·1, distal margin 9·3 ; *Distance from snout to*: 1st dorsal 30·9, 2nd dorsal 64·6, upper caudal 80·2, pectoral 24·8, pelvics 49·1 ; *Interspace between*: 1st and 2nd dorsals 24·4, 2nd dorsal and caudal 10·1 ; *Distance from origin to origin of*: pectoral and pelvics 24·2, 1st dorsal and pelvics 18·8, pelvics and 2nd dorsal 16·0, pelvics and caudal 'pit' 31·3 ; *Dorsal fins from origin (ahead of spine) to posterior free tip*: 1st dorsal 13·3, 2nd dorsal 10·3 ; *Exposed length of dorsal spines*: spine of 1st dorsal 2·5, spine of 2nd dorsal 3·0 ; *Clasper*: from origin of pelvic to tip of clasper 12·7, anterior end of vent to tip of clasper 11·1, inner angle of pelvic to tip of clasper 5·9.

Trunk slender, its height at origin of pectoral about 1/7 its length to origin of caudal and 1/9 of total length; dorsal profile sloping gently to snout from base of dorsal ; pre-vent distance almost equal to length of post-vent part of body including tail ; caudal peduncle flattened below with a low longitudinal dermal ridge laterally below mid-level extending from behind base of second dorsal to behind origin of caudal ; upper precaudal pit not well developed ; lower caudal pit absent.

Dermal denticles on sides of body (below 1st dorsal) lying in close contact, but not overlapping ; each denticle expanded laterally and presenting a tridentate shape with a median ridge and median process more elongate (Fig. 1, *h–k*) ; head about ¼ of total length and moderately flattened above with snout broadly ovate anteriorly ; snout length in front of mouth much less than half length of head (about 36%); eye longer than high, its horizontal diameter equalling distance between nares and anterior margin of mouth ; spiracle just behind eye being about 1/3 horizontal diameter of eye with its lower margin in level with middle of eye ; gill openings almost evenly spaced, the first opening being slightly smaller ; nostrils more or less horizontal, its inner end distinctly nearer tip of snout than to anterior margin of mouth ; anterior margin of nostril bilobed, the inner secondary lobe being small (Fig. 1, *c*) ; disposition of larger mucous pores and sensory canals on head as shown in Fig. 1, *b* and *c*.

Teeth triserial in both jaws and are essentially similar in shape, though teeth on lower jaw are slightly larger ; each tooth with a single sharp pointed cusp which is deflected laterally (Fig. 1, *g*). The number of teeth in each row (outermost row mentioned first) of upper and lower jaw is as follows :

Upper jaw : 8/8 ; 13/13 ; 13/13.
Lower jaw : 11/11 ; 12/12 ; 11/11.

Dorsal spines are strong, pointed, partly exposed and do not bear any lateral grooves but are flat along posterior side ; Claspers well developed, each bearing along its inner posterior edge a sharp recurved hook inner to which is present a flap-like fold ; anterior to this fold is present a laterally directed almost straight strong spine which projects postero-laterally oustide the clasper (Fig. 1, *d–f*).

Colour dark grey throughout with no indications of white spots ; inner side of claspers and skin around vent pale white.

Remarks.—In their monumental work on the Fishes of the Western North Atlantic, Bigelow and Schroeder (1948) stressed the need for a revision of the sharks of the suborder Squaloidea, which they subsequently studied and reported (1957). The other comprehensive accounts dealing with squaloid sharks are by Regan (1908), Garman (1913), and Fowler (1941). Bigelow and Schroeder (1957) while clarifying the systematic position of the various nominal species of the genus *Squalus* Linnaeus recognised three species complexes or divisions of *Squalus* as *Acanthias* division, *Fernandinus* division, and *Megalops* division, on a combination of characters, namely, the position of the first dorsal in relation to the paired fins, the shape of the pectoral, the nature of the narial flap and the shape of the dermal denticles. In all these diagnostic characters our specimen agrees fully with the characteristics given for the *Fernandinus* division, and particularly with the salient characters of *S. fernandinus*. At present *S. blainvilli* (Risso, 1826), *S. acutipinnis* Regan (1908), and *S. philippinus* Smith and Radcliffe (1912) (= *S. montalbani* Whitley, 1931) are considered synonyms of *S. fernandinus*. In the Indian Ocean this species has been reported by Regan (1908) from Mauritius (as *S. acutipinnis*) and from South African Waters as *S. blainvillii* (Bleeker, 1860; Günther, 1870); as *S. acutipinnis* (Regan, 1908 *a*; Barnard, 1925); and as *S. fernandinus* (Gilchrist, 1922; Smith, 1949). For records of *S. fernandinus* from the Pacific and Atlantic Oceans and the Mediterranean reference is invited to Bigelow and Schroeder (1948, 1957). According to these authors (1948), this species has a circumpolar distribution occurring in boreal and cool temperate latitudes of the southern hemisphere and is also "represented in the Philippines and Japan by forms so closely allied that it is a question whether they are separable from it". In this context also the present record of *S. fernandinus* from Indian Seas is of added interest.

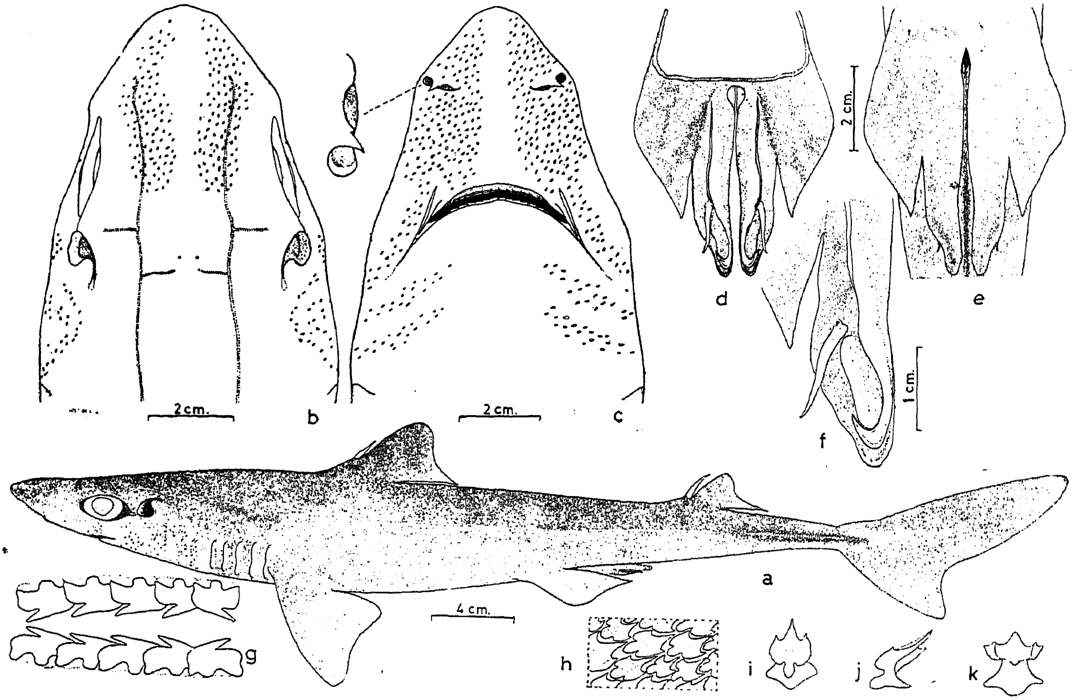

FIG. 1. *Squalus fernandinus* Molina. *a*, Lateral view of male 495 mm. in T.L.; *b* and *c*, Dorsal and ventral views of head of same: *d*, Dorsal view of clasper; *e*, Ventral view of clasper and pelvic fin; *f*, Dorsal view of clasper showing details; *g*, Teeth of upper and lower jaws; *h* to *k*, Dermal denticles.

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LETTERS TO THE EDITOR

AN INTERESTING GEOMETRICAL PROPERTY OF VAIDYA'S ANALYTICAL SOLUTION FOR GRAVITATIONAL COLLAPSE WITH RADIATION

In a recent paper Vaidya[3] has given an analytical solution for gravitational collapse with radiation. The metric may be expressed in spherical polar co-ordinates r, θ, ϕ and time t as

$$ds^2 = -e^{A}\,dr^2 - e^{B}\,(d\theta^2 + \sin^2\theta\,d\phi^2) + e^{C}\,dt^2 \tag{1}$$

where

$$e^{A} = \frac{S^2(t)\,e^{-2R(r,t)}}{(ar^2 + br + 1)^2}, \quad e^{B} = \frac{S^2(t)\,r^2\,e^{-2R(r,t)}}{(ar^2 + br + 1)},$$
$$e^{C} = e^{2R(r,t)}, \tag{2}$$

a, b being arbitrary functions of $u(r,t)$ which is conserved along the world-lines of the flow of radiation. We have

$$u' = f(u)\,(ar^2 + br + 1)^{-1}$$
$$\dot{u} = -f(u)\,e^{2R(r,t)}\,S^{-1}, \tag{3}$$

f being arbitrary. Here and in what follows a prime and overhead dot represent respectively a differentiation with respect to r and t. The relation between u and R is given by

$$2R'(ar^2 + br + 1) = -u'\left[\left(\frac{da}{du}\right)r^2 + \left(\frac{db}{du}\right)r\right]. \tag{4}$$

The purpose of this note is to show that the space-time described by the metric (1) with (2)–(4) is conformally flat.

It was shown by Krishna Rao[1] that the most general spherically symmetric non-empty space-time [given by (1) with A, B, C as functions of r and t only] is of type D in Petrov-Pirani classification. The only non-vanishing physical component of Weyl's conformal tensor is given by

$$\epsilon = (1/12)\,[e^{-A}\,(2B'' - 2C'' - C'^2 - A'B' + B'C' + C'A') + e^{-C}\,(2\ddot{A} - 2\ddot{B} + \dot{A}^2 - \dot{A}\dot{B} + \dot{B}\dot{C} - \dot{C}\dot{A})] + (1/3)\,e^{-B}.$$

When $\epsilon = 0$, the space-time is conformally flat. Although it is long and tedious one can now compute in a straightforward manner and show that $\epsilon = 0$ for the metric (1) with (2)–(4) and hence we conclude that the space-time geometry of the radiating star under gravitational collapse is conformally flat. It is worth pointing out that Vaidya's solution is a particular case of a general result of Krishna Rao[2] which may be stated as follows:

Given a perfect fluid solution of Einstein's field equations having a conformally flat metric one can always include the presence of a pure radiation stress-energy tensor $\sigma k_a k_b$, $k_a k^a = 0$, without disturbing the conformally flat nature of the space-time.

The author wishes to express his thanks to Dr. J. Krishna Rao for suggesting the problem and guidance in the preparation of this note.

Department of Mathematics,
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Vallabh Vidyanagar,
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R. B. Patel.

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DUAL CORE MODEL FOR He^3

Following the author's previous work[1] an attempt has been made to estimate the ground state energy of He^3 nucleus based on the suggested dual core model. Earlier investigators[2] have made estimates of this ground state energy on three nucleon variational calculations whereas, in the present work, He^3 nucleus is treated as a resonating structure of two deuterons with single neutron forming a deuteron with either of the protons, existing as an entity. The high instability of the free diproton and dineutron nuclei and the nuclear stability of H^3 and He^3 nuclear structures justify the stabilizing role of the third nucleon of the He^3 nucleus. The presence of the diproton as an entity inside the He^3 is also rendered plausible by the experimental evidence of the pronounced p-p final state interaction.[3]

In the present model, the neutron moves essentially in an average field formed by itself and the diproton. The two protons give rise to two distinct symmetrical cores separated by a distance R which is of the order of the He^3 nuclear radius, as required by the saturation property of nuclear binding forces. When a neutron is near one of these two cores it moves in a potential field consisting of the overall potential $-U_0$ and the individual harmonic potential field arising due to that core. The total Hamiltonian of the system due to these potential fields and also the diproton Coulomb fields has been set up and a variational calculation is used to evaluate the ground state energy.

To arrive at the experimental value of the binding energy, the overall potential U_0 is expressed as $U_0 = 2 V_0 \lambda e^{-\lambda}$ with $\lambda = (R - b)/b$ and the effective range of nuclear forces $b = 1{\cdot}5$ fm. The variable parameter V_0 thus represents the individual nucleon contribution to the overall potential of He^3 nucleus. To furnish He^3 binding energy of 7·72 Mev, a value of 20 Mev. is required for V_0.

However, both ψ_A and ψ_S wave functions yield bound states and this difficulty is resolved, when the overall potential is modified as:

$$U_0 = 3 V_0 \lambda e^{-\lambda} \left[\frac{(1 + P_M)}{2}\right]$$

where P_M is the Majorana exchange force operator between the two protons. The Majorana operator allows only the ψ_S as the stable state with the protons existing as a singlet spin system.

Using the experimental binding energy 7·72 Mev, the values $V_0 = 14{\cdot}4$, 11·4 and 9·2 Mev are obtained respectively with individual harmonic oscillator frequency of the symmetrical cores as $\nu = 0{\cdot}32$, 0·24 and 0·17 fm^{-2}. A decrease in the frequency ν leads to an increase of the overlap of neutron binding orbitals and hence to a lesser value of the individual nucleon contribution to the overall potential.

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FORCE FIELD, MEAN SQUARE AMPLITUDES AND CORIOLIS COUPLING COEFFICIENTS OF DICHLOROFLUOROAMINE

DICHLOROFLUOROAMINE belongs to Cs point group having 6 normal modes of vibration $4a' + 2a''$. Detailed analysis of the infrared spectrum of $NFCl_2$ was done by Hirschmann *et al.*[1] The present investigation deals with the calculation of potential constants, generalised mean square amplitudes and Coriolis coupling coefficients of this molecule. Force constants are obtained by the method of Wilson[2] and generalised mean square amplitudes by that of Morino and Hirota.[3] According to Jahn's Rule,[4] $NFCl_2$ has one active Coriolis coupling $a' \times a''$ corresponding to both ζ^x and ζ^y as per the co-ordinate system followed. The Coriolis coupling coefficients are calculated by the method of Meal and Polo.[5]

Force constants, generalised mean square amplitudes and Coriolis coupling coefficients are given in Tables I, II and III respectively.

TABLE I

Force constants (md/Å) of $NFCl_2$

f_R	3·2140	f_α	0·5678	f_β	0·4353
f_r	2·6770	$f_{R\alpha}$	0·1688	$f_{R\beta}$	−0·1377
f_{rR}	0·2693	$f_{r\alpha}$	−0·0423	$f_{r\beta}$	0·0959
f_{rr}	0·0004	$f_{\alpha\alpha}$	0·0923	$f_{\alpha\beta}$	−0·0220
$f_{r\alpha}$	0·3514				

Where N−F = R = 1·37 Å, N−Cl = r = 1·70 Å, FNCl = α = 102°, ClNCl = β = 106°.

TABLE II

Generalised mean square amplitudes $(Å)^2$ *at 300° K. of* $NFCl_2$

Atom pair	N–F	N–Cl	F...Cl	Cl....Cl
$(\Delta z)^2$	0·002717	0·002883	0·003367	0·006830
$(\Delta y)^2$	0·003792	0·002400	0·004898	0·001658
$(\Delta x)^2$	0·005310	0·003899	0·000211	0·001185
$(\Delta z \Delta y)$	0·000000	0·002580	−0·000326	0·000000
$(\Delta z \Delta x)$	−0·000302	0·001535	−0·000684	0·000000
$(\Delta y \Delta x)$	0·000000	−0·000690	0·000579	−0·000302

TABLE III

Coriolis coupling coefficients of $NFCl_2$

Coupling	ζ^x	ζ^y	Coupling	ζ^x	ζ^y
ζ_{15}	−0·4125	0·6417	ζ_{16}	0·3472	0·4874
ζ_{25}	−0·6777	−0·4942	ζ_{26}	0·1136	0·1288
ζ_{35}	0·3927	0·2343	ζ_{36}	−0·1832	−0·5967
ζ_{45}	0·3246	0·4192	ζ_{46}	−0·0338	0·6289

The generalised parallel mean square amplitude of N-F bond is slightly smaller than that bond while the perpendicular mean plitudes of N-F and N-Cl bonds are ferent. The ζ values obtained in this on show that the Coriolis coupling lifferent modes of vibration is rather owever, there exists fairly strong between N-Cl symmetric and N-Cl etric stretching modes of vibration as tween the FNCl symmetric and FNCl etric bending modes of vibration.

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AL EXPANSION OF CADMIUM MOLYBDATE

ent study of thermal expansion of molybdate is a part of our programme y studies on scheelite-type com- We have already reported the the precision determination of lattice s and thermal expansion of KIO_4[1], $SrWO_4$[3], $BaWO_4$[4] and $CaMoO_4$[5]. of literature shows that except for n temperature lattice parameter data, o work on their temperature varia- $CdMoO_4$.

hips of cadmium molybdate crystals, from Dr. R. R. Soden of the Bell Laboratories, U.S.A., were crushed ler form to fill the specimen cup of -reflection-focussing camera.[6] The tal technique employed and the used in the evaluation of accurate the lattice parameters, their standard the coefficients of thermal expansion tially the same as described in earlier ns.[3-5] The reflections which were ously indexed and employed in g the values of the *a* and *c* para- were $(2.2.12)_{\alpha_1\alpha_2}$. $(3.3.10)_{\alpha_1\alpha_2}$, and $(536)_{\alpha_1\alpha_1}$. The lattice para- btained at different temperatures are Table I and are shown in Fig. 1.

TABLE I

Lattice parameters of $CdMoO_4$ at different temperatures

Temperature ° C.	*a* Å	*c* Å
30	5·1559 ±0·0004*	11·1950 ± 0·0020*
70	5·1580	11·2035
105	5·1588	11·2059
165	5·1625	11·2202
210	5·1645	11·2278
265	5·1671	11·2367
310	5·1697	11·2443
355	5·1729	11·2558

* Standard errors as calculated by Jette and Foote method.[7]

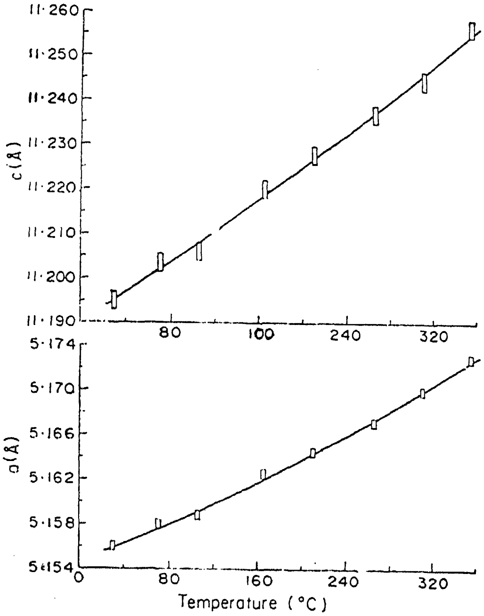

FIG. 1. Temperature variation of the lattice parameters of $CdMoO_4$.

Least-square fitting of the temperature-parameter data gave the following expressions for the temperature dependence of *a* and *c*.

$$a_t = 5 \cdot 1548 + 38 \cdot 38 \times 10^{-6} t + 33 \cdot 40 + 10^{-9} t^2$$
$$c_t = 11 \cdot 1903 + 164 \cdot 19 \times 10^{-6} t + 48 \cdot 10 \times 10^{-9} t^2.$$

Here a_t and c_t are the two parameters in Å units at temperature t° C.

The values, of the two principal coefficients of expansion α_a along *a*-axis and α_c along *c*-axis, at different temperatures, calculated from the temperature-parameter plots are given in Table II.

TABLE II

Coefficients of thermal expansion of $CdMoO_4$ at different temperatures

Temp. (°C.)	$\alpha_a \times 10^6$		$\alpha_c \times 10^6$	
	Obs.	Calc.	Obs.	Calc.
30	..	6·85	..	15·13
40	7·27	7·09	15·28	15·21
60	7·47	7·56	15·41	15·37
100	8·34	8·45	15·63	15·72
140	9·21	9·29	16·44	16·10
200	10·38	10·42	16·53	16·75
240	11·25	11·10	16·97	17·22
300	11·93	12·01	18·13	18·00
340	12·88	12·53	18·54	18·56
350	..	12·66	..	18·70

The temperature dependence of the coefficients could be expressed by the following equations:

$$\alpha_a = 6\cdot10 \times 10^{-6} + 25\cdot43 \times 10^{-9}\, t - 19\cdot15 \times 10^{-12}\, t^2$$

$$\alpha_c = 14\cdot91 \times 10^{-6} + 7\cdot00 \times 10^{-9} t + 10\cdot98 \times 10^{-12}\, t^2$$

where t is in °C. The values of α_a and α_c calculated by using these two equations are also given in Table II.

In Table III the lattice parameters of $CdMoO_4$ obtained at room temperature are compared with a few others available in literature. There is good agreement between the present values and those reported by Swanson *et al.*[9]

TABLE III

Lattice parameters of $CdMoO_4$ at room temperature

Authors		a Å	c Å
Donnay and Nowacki[8]	..	5·148 ±0·003	11·17 ± 0·02
Swanson *et al.*[9]	..	5·155	11·194
Chichagov *et al.*[10]	..	5·17	11·19
Present study	..	5·1559 ±0·0004	11·1950 ± 0·0020

It is worth a mention that in $CdMoO_4$, the coefficients of expansion along the tetragonal axis is larger than that along the *a*-axis and remains larger throughout the temperature range covered, a feature observed in other scheelite-type crystals also.

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K-ABSORPTION SPECTRUM OF 1-AMIDINO-2-THIOUREA COMPLEX OF NICKEL (II)

RECENTLY several workers[1-7] have studied the electronic structure of transition metal complexes and have correlated their results obtained from the X-ray absorption spectroscopy with magnetic measurements. In the present paper, the authors have studied the K-absorption spectrum of a freshly prepared chelate of nickel[8] (II), *viz.*, nickel (II) complex of 1-amidino-2-thiourea, Ni $(ATU)_2$ and have attempted to correlate the observed results with the structure proposed by Paigankar.[9]

A 40 cm. focussing spectrograph of Cauchois type mentioned elsewhere[10] was used in this investigation. The (201) and (100) planes of mica which served as the diffracting crystal gave a dispersion of about 12 X.U. mm.$^{-1}$ in the first order. A sealed X-ray tube with copper target was operated at 10 KV and 6 mA. Exposure times varied from 40 to 50 hours on the ORWO X-ray films.

Absorbing screens were prepared by pressing the compound between two thin mylar sheets. After several trials screens of suitable thicknesses were obtained which gave maximum contrast in the absorption spectra. The screens were placed in between the crystal holder and the photographic plate. A microphotometer $M_{\phi 4}$ both recording and the direct reading type was used in this investigation.

Figure 1 shows a microphotometer tracing of the K-absorption spectrum of Ni (ATU)$_2$.

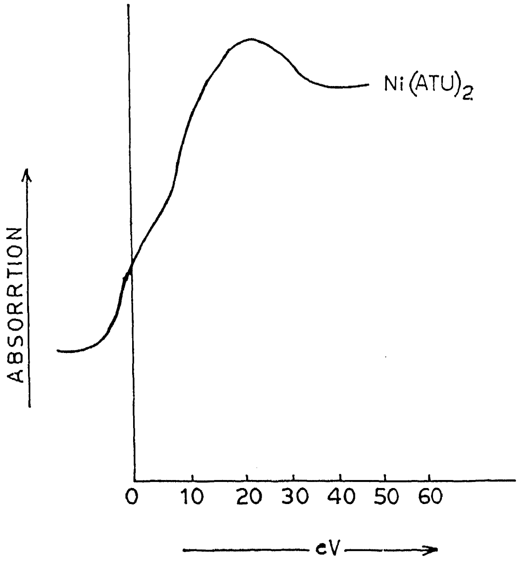

FIG. 1. K-absorption edge of Ni(ATU)$_2$.

The first slope of the metal edge has been chosen as the zero of the energy scale which corresponds to $1s \rightarrow 3d$ transition in the metallic state. The absorption edge of Ni (ATU)$_2$ shows a shift with a maximum at 20·2 eV. It should be noted that the Square planar K$_2$Ni(CN)$_4$ also exhibits a strong absorption maximum near around 20 eV[11,12] and so it may correspond to the transition of 1s electron to the antibonding molecular orbital a_{2u} (π^*) which is formed by the combination of $4p_z$ orbital of Ni(II) and π-orbitals of the ligand.[13] Here, it is assumed that the ligands are present along x- and y-axes. Earlier, the absorption maximum at ~ 20 eV in K$_2$Ni(CN)$_4$ was assigned to the transition $1s \rightarrow 5p$ because antibonding molecular orbitals were not considered. Further studies are necessary to assign the weak peak (~ 5 eV) at lower energy below the main peak in K$_2$Ni(CN)$_4$. The results of present investigation are consistent with the suggested planar structure of diamagnetic Ni(ATU)$_2$.[9]

Department of Physics, B. D. PADALIA.
Indian Institute of C. S. GUPTA.
Technology,
Bombay-76,
and
Inorganic and Nuclear ANIL PAIGANKAR.
Chemistry Laboratory, B. C. HALDAR.
Institute of Science,
Bombay-32, *June* 23, 1969.

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EMISSION SPECTRA OF *o*- *m*- AND *p*-TOLUALDEHYDES

SPECTRA due to the n-π^* electronic transition in carbonyl compounds have drawn the attention of several workers.[2,3] Benzaldehyde is the simplest molecule among substituted benzenes which contain C=O group and its n-π^* system has been studied extensively in absorption as well as in emission. It was considered desirable to record the electronic spectra of isomeric tolualdehydes. Singh and Singh[1] had earlier made a detailed study of absorption spectra of the *o*-, *m*- and *p*-tolualdehydes. In the present note we report the studies of their emission spectra which are counterparts of the absorption systems. The complete paper will be published in due course. In each of the tolualdehydes about 150 bands were observed in emission and they could be interpreted in terms of the fundamental modes of vibration of the molecules in their ground state. A prominent feature in emission spectra in the three molecules is the occurrence of a long progression upto six members, of the carbonyl C=O frequency. Further, the (0, 0) bands show a progressive increase towards the higher frequency from 26853 cm.$^{-1}$ *ortho*, to 26943 cm.$^{-1}$ in *meta* to 27090 cm.$^{-1}$ in *para* tolualdehydes as expected.

Dept. of Spectroscopy, KAMALESH SINGH.
Banaras Hindu University, V. B. SINGH.
Varanasi-5, *June* 28, 1969.

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OXIDIMETRIC ESTIMATION OF MORPHOLINE IN ITS METAL COMPLEXES AND MORPHOLINIUM SALTS

MORPHOLINE (also called tetrahydro 1, 4-oxazine) is a heterocyclic saturated secondary amine of moderate strength. ($K = 2 \cdot 44 \times 10^{-6}$ in water at 25° C.). An aqueous solution of morpholine can be quantitatively titrated against standard hydrochloric acid using methyl red as indicator. From an aqueous solution containing 20% or more of sodium hydroxide morpholine can be extracted with ether without removal of any fixed alkali, the ether solution of morpholine can be mixed with water and titrated with standard hydrochloric acid. By treatment with excess solution of alkali morpholine can also be quantitatively recovered in small volume by steam distillation or direct distillation.

However, there is no report of any suitable procedure in literature for determining morpholine either in its metal complexes or in morpholinium salts. In acid solution of potassium permanganate only slow oxidation takes place. Morpholine reacts with aqueous hydrogen peroxide at 0° C. to give low yield of 4-hydroxymorpholine.[1] The above two reactions cannot be used for the quantitative determination of morpholine. The reaction of morpholine with aqueous sodium hypochlorite in the cold to give N-chloromorpholine[1] seemed promising for the quantitative determination of morpholine. In this communication a procedure has been described for the quantitative determination of morpholine (or morpholinium ion) which is based on the conversion of morpholine to N-chloromorpholine and determination of this iodometrically.

A weighed amount of the dry complex (or morpholinium salt) containing about 2 m. moles of morpholine was treated with 25 ml. of 2 N sodium hydroxide solution (to liberate morpholine) and treated with 100% excess of 0·1 N sodium hypochlorite solution to oxidise the free morpholine to N-chloromorpholine. After 5–10 minutes the aqueous phase was shaken with 20 ml. portions of ether thrice and the ether layer separated. The hypochlorite was not extracted to ether under these conditions but the N-chloromorpholine was quantitatively extracted. The combined ether extracts were washed with 10 ml. of water three to four times and treated with 20 ml. of 10% potassium iodide solution and 20 ml. of 2 N sulphuric acid. The N-chloromorpholine was quantitatively reduced to morpholinium ion liberating an equivalent amount of iodine according as:

$$C_4H_8ONCl + 3\,I^- + 2\,H^+ \rightarrow C_4H_8ONH_2^+ + I_3^- + Cl^-.$$

After keeping the solution in the dark for 5 minutes the liberated iodine was titrated against standard sodium thiosulphate solution. From the amount of thiosulphate consumed the amount of morpholine in the complex (or morpholinium salt) was determined. Experiments carried out with solutions of morpholinium salts of known strength gave highly accurate results reproducible to ± 0·3% of the theoretical value. Metal ions such as Zn(II), Cd(II), Hg(II), Co(II), Ni(II) and Cu(II) were found not to interfere in this estimation.

Department of Chemistry,
Indian Institute of Technology,
Madras-36, *July* 21, 1969.

D. VENKAPPAYYA.
G. ARAVAMUDAN.

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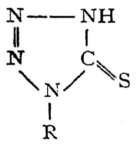
QUALITATIVE REACTION OF 1-SUBSTITUTED TETRAZOLINE-5-THIONES WITH BISMUTH (III)

VARIOUS 1-substituted tetrazoline-5-thiones (I) have recently been introduced[1-6] as unusually versatile complexing reagents in the gravimetric determination of a number of metals, such as Cu, Cd, Hg, Zn, Bi, Au, Ag, Pd and Pt. The complex forming properties of these ligands have also been employed to study the nature of, hitherto little understood, metal-sulphur bonds.[3,7] Hence, it is desirable to have a suitable procedure for their detection and identification.



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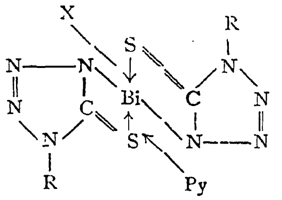

II

(X = a monovalent anion;
R = an alkyl or aryl group).

Earlier methods for the detection of tetrazoline-5-thiones were based only on their i.r. spectra[8] and u.v. spectra.[9] During the present study, we examined the behaviour of a number of 1-substituted tetrazoline-5-thiones towards a large number of metal ions, but a common reaction was observed only in case of Bi^{3+} ions.

All the tetrazoline-5-thiones examined were found to give a yellow precipitate specifically with Bi^{3+} ions. The yellow precipitate turned deep yellow on the addition of a drop or two of pyridine. In certain cases, a similar colour darkening was also observed with quinoline. No other cation including Sb^{3+} gave a yellow precipitate with these heterocycles.

The i.r. spectra of the yellow precipitates with and without pyridine were examined on a Perkin-Elmer Grating Spectrophotometer (Model 521) in region of 4000–400 cm.$^{-1}$ on KBr pellets. The spectral data of these complexes were almost identical with those reported in literature for other metal-tetrazoline-5-thione complexes.[3] This observation thus clearly established the formation of inner complexes of type II between 1-substituted tetrazoline-5-thiones and bismuth (III) ions.

The elemental analysis of bismuth(III) complexes of 1-phenyltetrazoline-5-thione and *p*-phenylene-di-(1-tetrazoline-5-thione) (prepared by the reaction of respective ligand with a solution of $BiCl_3$ in presence of pyridine) gave satisfactory results for C, H, N, and Cl; the analyses were based on the structure II.

Since the above reaction is specifically carried out in presence of bismuth ions, it may also be used in the detection of bismuth(III). Antimony is unlikely to cause any interference.

Recommended Procedure for the Detection of 1-Substituted Tetrazoline-5-Thiones.—Take 1 ml. of 1% bismuth nitrate solution in a micro test-tube, and add 5 drops of an acetone or alcoholic solution of tetrazoline-5-thione compound and 1 drop of pyridine. A positive response will be indicated by the appearance of a yellow colour or precipitate.

Sensitivity: 500 γ tetrazoline-5-thione.

The sodium salts of 1-substituted tetrazoline-5-thiones behave similar to those of their acid forms. The sodium salts are soluble in water. The following compounds were tested: 1-Phenyl tetrazoline-5-thione; 2 : 4-Dichlorophenyl-(1-tetrazoline-5-thione); 1-*p*-Iodophenyl tetrazoline-5-thione; 1-*m*-Chlorophenyl tetrazoline-5-thione; 1-*p*-Bromophenyl tetrazoline-5-thione; *m*-Phenylene-di-(1-tetrazoline-5-thione); *p*-Phenylene-di-(1-tetrazoline-5-thione) and 4-Chloro-*m*-phenylene-di-(1-tetrazoline-5-thione).

Recommended Procedure for the Detection of Bismuth (III).—Take 3 drops of a 2% acetone or alcoholic solution of 1-phenyltetrazoline-5-thione (or any other tetrazoline-5-thione or an aqueous solution of its sodium salt) in the groove of a spot plate. Then add 1 drop of pyridine and two drops of the sample solution containing bismuth(III). A yellow colour or precipitate indicates the presence of bismuth. Large amounts of antimony do not interfere.

Sensitivity: 100 γ Bi^{3+} ions.

Dept. of Chemistry, G. S. Johar.
V.S.S.D. College, Kanpur,

Dept. of Chemistry, Umesh Agarwala.
Indian Institute of
Technology,
Kanpur, *June* 17, 1969.

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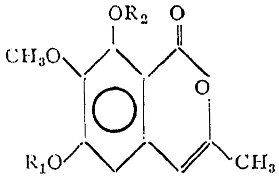
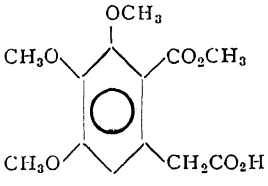
SYNTHESIS OF O-DIMETHYL ETHER OF RETICULOL AND (±) 5-METHYL MALLEIN

Reticulol, m.p. 193–93·5°, a new metabolic isocoumarin, has been isolated from *streptomyces rubrireticuli* by Mitscher *et al.*[1] and structure (I) was advanced on the basis of



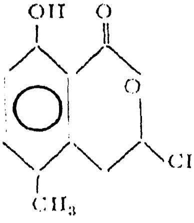
I. $R_1=R_2=H$
II. $R_1=CH_3$; $R_2=H$
III. $R_1=R_2=CH_3$



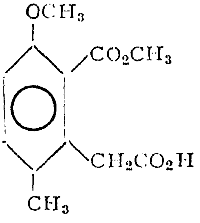
IV

chemical reactions and spectral properties. The dimethyl ether of reticulol (III) has been synthesised as given below:

5, 6, 7-Trimethoxy-indan-1-one was prepared from trimethyl gallic acid by standard route.[2,3] 2-Nitroso derivative, m.p. 201–2°, was prepared by the action of methyl nitrite on the ketone in presence of hydrochloric acid. On Beckmann rearrangement with p-toluenesulphonyl chloride and subsequent hydrolysis with alkali afforded 3, 4, 5-trimethoxyhomophthalic acid, m.p. 141–42°, which was converted into dimethyl ester (b.p. 180°/0·5 mm.) by the action of diazomethane. On semi-hydrolysis wiih methanolic-caustic potash 2-methoxycarbonyl-3, 4, 5-trimethoxyphenylacetic acid (IV), m.p. 148–50°, was obtained in good yield. The related acid chloride on treatment with diethyl ethoxy-magnesiomalonate and subsequent work up gave (II), m.p. 193–94°, which after methylation with methyl iodide and potassium carbonate in acetone solution gave (III), m.p. 119°, identical with the dimethyl ether of reticulol prepared by the action of methyl iodide and potassium carbonate in acetone solution. We are thankful to Dr. E. Petterson of American Cyanamide Company, New York, for providing a small sample of natural product for comparison and experimentation.



V



VI

In a similar manner (–) 5-methyl mallein (V) isolated by Ballio *et al.*[4] from the phytotoxic metabolite of *Fosicocum amygdali* has been synthesised in the racemic form. Thus 4-methyl-7-methoxyindan-1-one[5] was converted into 2-nitroso derivative, m.p. 244–45° (decomp.). This was converted into 3-methyl 6-methoxyhomophthalic acid, m.p. 169–70°, in the usual manner. The dimethyl ester (b.p. 175–80°/1·0 mm.) on partial hydrolysis gave 2-methoxycarbonyl-3-methoxy-6-methylphenylacetic acid (VI), m.p. 108–9°. Reaction of the related acid chloride with diethyl ethoxy-magnesiomalonate afforded 3, 5-dimethyl-8-hydroxyisocoumarin, m.p. 150–51° (blue ferric reaction, the methoxy adjacent to the carbonyl group is lost during treatment with HCl). This on hydrogenation with palladised charcoal and acetic acid afforded (±) 5-methylmallein (V) which was obtained in colourless woolly needles, m.p. 140–41° characterised by the O-methyl ether, m.p. 139–40° (negative ferric reaction).

The authors express their thanks to the Council of Scientific and Industrial Research, India, for the grant of Junior Research Fellowships to two of them (C. B. and J. M.).

Department of Chemistry,
Patna University,
Patna, *June* 17, 1969.

J. N. CHATTERJEA.
(MRS.) J. MUKERJI.
C. BHAKTA.
B. K. BANERJEE.

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CATECHINS FROM CASHEWNUT TESTA

IN continuation of our earlier report[1] on the polyphenols of the different parts (flowers, leaves and barks) of *Anacardium occidentale,* we have chemically examined the cashewnut testa available commercially in Kerala in such quantities that it is used as wholesome poultry feed,[2] and our results are recorded in brief:

The testa collected from Kayamkulam in Kerala State was extracted with ether by cold maceration four times, each time lasting for 24 hr. The combined extract was concentrated *in vacuo* to a reddish-brown syrup, which was repeatedly treated with hot petroleum ether and benzene in succession. The residue from the petroleum ether and benzene extracts was mainly oily, and on chromatography on alumina yielded a small quantity of β-sitosterol. The semi-solid left after treatment with petroleum ether and benzene was taken in minimum of hot methanol and poured into a large quantity of ice-cold water, when an almost colourless amorphous solid separated. It was digested with hot benzene and filtered. The dry crystalline solid obtained was recrystallised from hot water; on paper chromatography this was found to be a mixture of catechins (astringent taste and colour reactions). Further separation was achieved by fractional crystallisation from ethyl acetate or hot water; the less soluble fraction on repeated recrystallisation came out as colourless prisms, $C_{15}H_{14}O_6$, m.p. 240–42°. $[\alpha]_D^{30} - 68 \cdot 1$ (yield, 5%). It gave a green colour with alc. $FeCl_3$ and reduced Tollen's and Fehling's reagents. On acetylation with acetic anhydride and anhydrous sodium acetate, it gave a penta acetate, m.p. 151–52° and on methylation with dimethyl sulphate and potassium carbonate for 4 hr. in anhydrous acetone medium, a tetramethyl ether, m.p. 153–54°. These data agreed well with those of (−) epicatechin[3,4] and the identity of the compound was further confirmed by PC, TLC (single spot), UV, IR and NMR data.

The more soluble fraction obtained from the mother liquor after the removal of (−) epicatechin was almost colourless. On recrystallisation it came out as needles, m.p. 96–98° (anhydrous: 176–77°), $[\alpha]_D^{30} + 16\cdot8$ (yield, 4%). It exhibited all the properties of a flavan-3-ol. Its acetate melted at 130–32°, benzoate, 170–71° and methyl ether (complete methylation, 36 hr.), 94–95° all pointing towards the identity as (+) catechin[3,4] This identification was also confirmed by UV, IR and NMR data. The proanthocyanidins were studied in the subsequent acetone extract and leucocyanidin and leucopelargonidin as reported by Mathew[5] could be identified.

Recently, Mathew and Parpia[6] have identified the polyphenols of cashew kernel testa (50% aqueous acetone extract) by paper chromatography to be (+) catechin, (−) epicatechin, proanthocyanidins, leucocyanidin and leucopelargonidin in agreement with our results. They have also suggested that the darkening of cashewnuts during processing may be due to the interaction of polyphenols with iron.

The isolation of catechins from the cashewnut testa in such high yields is significant from the point of view of biosynthesis of polyphenols of *A. occidentale*, taken in conjunction with our earlier isolation of ethyl gallate[1] in significant amounts from the flowers; it points to a possible conversion of a C_6-C_1 system in the flower to a C_6-C_3-C_6 polyphenol in the fruit.

We are grateful to Prof. T. R. Govindachari, Director, Ciba Research Centre, Bombay-63, for UV, IR and NMR data and Drs. A. G. Mathew and H. A. B. Parpia of the C.F.T.R.I., Mysore, for the private communication of their results. Our thanks are due to Mr. K. Vijayan Pillai for the supply of plant material.

Dept. of Chemistry,
Jipmer,
Pondicherry-6,
S. Sankara Subramanian.
A. G. R. Nair.

July 8, 1969.

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Note added to the proof:

The identity of (−)-epicatechin and (+)-catechin was also confirmed by direct comparison, m.m.p. and co-chromatography with authentic samples from Prof. T. R. Seshadri, to whom we are grateful.

CHEMICAL EXAMINATION OF *SANTALOIDES MINUS*

Santaloides minus (N.O. Connaraceæ) commonly grows as a climbing shrub throughout the country. Its roots are widely used in Ayurvedic medicine as a bitter tonic, in rheumatism and pulmonary complaints.[1,2] The plant appears to have not been chemically examined to date. They have now been shown to contain β-D-glucoside of β-sitosterol, hentriacontane, β-sitosterol and meso-inositol.

The powdered roots (3 kg.) were exhausted with petroleum ether, b.p. 40–60° (4 × 8 L) by cold percolation. The total extract was concentrated to one litre and kept overnight.

β-D-glucoside of β-sitosterol.—A residue was deposited, which was filtered, washed with petroleum ether and on repeated crystallization from methanol afforded a colourless micro-crystalline product (800 mg.), m.p. 274–76°, $(\alpha)_D^{30°}$ − 36·2° (c, 1·4 pyridine) (Found C, 72·64; H, 10·52; $C_{35}H_{60}O_6$ requires C, 72·84; H, 10·48%). It gave positive Liebermann Burchard colour reaction and Molisch's test. Mixed m.p. with an authentic sample of β-D-glucoside of β-sitosterol was undepressed. It formed tetracetate, m.p. and mixed m.p. 165–67°, $(\alpha)_D^{30°}$ − 31° (c, 1·2 pyridine). The compound on acid hydrolysis with methanolic hydrochloric acid (7%, 8 hr.) furnished β-sitosterol as colourless needles, m.p. and mixed m.p. 134–36°, $(\alpha)_D^{30°}$ − 33°, acetate, m.p. and mixed m.p. 128–29° and benzoate m.p. 142–44°.

The solvent was completely removed from the filtrate. The semi-solid residue was saponified with alcoholic sodium hydroxide solution (10%, 4 hr.). The unsaponifiable matter on usual working and chromatography on alumina column yielded two compounds.

Hentriacontane.—On elution with petroleum ether, it was obtained as colourless shining plates (900 mg.), m.p. 66–68°. It was optically inactive and the I.R. spectrum in KBr showed absorption at 720 cm.$^{-1}$ (alkane). It analysed for $C_{31}H_{64}$ and gave no colouration with tetranitromethane. Mixed m.p. with an authentic sample of hentriacontane remained undepressed.

β-sitosterol was eluted with a mixture of petroleum ether and benzene (4 : 1). It crystallized from acetone as colourless needles (450 mg.), m.p. 135–37° and identified as above.

Meso-Inositol.—Petroleum ether exhausted roots were subsequently extracted with ethanol in cold. The ethanolic extract (6 × 4 L) was concentrated to 500 ml. and kept at room temperature for 48 hours. A crystalline residue was deposited on the walls of the container. The residue was filtered and on crystallization from methanol (charcoal) afforded colourless crystals, m.p. 221–23° (Found. C, 40·32; H, 6·38; $C_6H_{12}O_6$ requires C, 40·0; H, 6·66%). It was freely soluble in water and was optically inactive. It showed no depression in m.p. with an authentic sample of meso-inositol. The identity was further established by paper chromatography employing butanol, acetic acid and water (4 : 1 : 5), (upper layer) as solvent and aniline hydrogen phthalate as spray giving only one spot (R_f 0·12) identical to meso-inositol. Acetylation yielded inositol hexaacetate, m.p. and mixed m.p. 215–16° (Found C, 49·76; H, 5·82; $C_{18}H_{24}O_{12}$ requires C, 50·00; H, 5·55%).

The authors are highly thankful to the Director, Indian Veterinary Research Institute, Izatnagar, for his keen interest in these investigations.

I.V.R.I., Izatnagar (U.P.), June 16, 1969.

SURESH CHANDRA.
V. S. BISARIA.
R. K. GUPTA.

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ELECTROPHORETIC SEPARATION OF RNA FROM SNAIL EMBRYOS

TSANEV[1] claimed that agar-gel electrophoresis would clearly separate RNA of various S values. Later Dessev *et al.*[2] reported separation of ribosomes by ion-agar electrophoresis.

We have now succeeded in obtaining reasonably clear separation of embryonic RNA from *Limnœa* with the help of ion-agar electrophoresis and compared the results with sucrose-density-gradient. It seems that though in many respects ultracentrifugation is a superior method, considerable information can be obtained with this very simple technique of electrophoresis and at least in one respect it is more valuable than density-gradient.

Limnœa eggs and embryos collected from the pond or from vessels in the laboratory (maintained on dry lettuce) were fed with ^{32}P (Trombay) isotope solution at different developmental stages and the RNA was extracted by shaking with hot phenol.[3] Marker RNA, *i.e.*, non-radioactive RNA was likewise extracted from *E. coli* and mixed with snail RNA and precipitated by cold alcohol. After centrifugation the RNA pellet was dissolved in 0·1 ml. 20% potassium acetate and 0·1 ml. NaCl (final molarity 0·05). 1·25% ion-agar (dissolved in citrate-phosphate buffer[4]) was melted and 4–5 ml. of this fluid was allowed to set on a microscope slide of usual dimensions. About an hour or so after preparing this layer a groove was cut on the slide and the RNA solution was introduced into the groove and allowed to soak in. After this the two ends of the slide were connected to the baths containing the citrate-phosphate buffer (pH about 8) and the electrophoretic run was allowed to last for 60–75 minutes at a voltage of 350 and constant current of 29 mA.

After this the slide was put in a mixture of phosphate buffer and toludine blue (final concentration of toludine blue being 0·1%) in order to stain the RNA bands and wash out the free ^{32}P. After 30–40 minutes of staining and 10–20 minutes of washing in running water the three marker RNA bands (*i.e.*, *E. coli* RNA of 23S, 16S and 4S fractions) would be visible. According to earlier findings[1] the heaviest RNA fraction lies nearest to the origin and as such the individual marker bands can be recognized. Under good conditions the separation between the bands would be as much as 4–5 mm. In such cases, not only the bands but the intermediate regions could be cut out. More often because of diffusion, etc., the clear separation space would be much less. As it has already been found that the γ RNA of *Limnœa* embryos have very nearly the same S values as those of the bacterial γ RNA,[3] it was now attempted to cut out the three bands in order to test their relative radioactivity. The cut pieces were washed again overnight in cold (non-radioactive) phosphate buffer in order to remove the ^{32}P. This was followed by another washing next day. In order to be sure that the major part of free ^{32}P has been removed, a piece larger than the bands was cut out either in the pre-23S or in the post-4S region and its radioactivity was tested. This fraction gave low counts.

TABLE I

The relative values of biosynthesis of different RNA fractions in different stages of development of Limnaea *embryos*

Stage	Bands	c m
Morula	23 S	331
	16 S + 16–4 S	252
	4 S	162
Trochophore	23 S	532
	16 S + 16–4 S	1796
	4 S	335
Veliger	23 S	2641
	16 S + 16–4 S	3200
	4 S	152

Counts were taken after dissolving the pieces of agar in planchettes by heating with 1 ml. of water. The gel in planchettes was then allowed to set uniformly or the planchettes were altogether dried.

In this manner it was found that the counts in the middle region, that is 16S and 16–4S were highest at the trochophore stage (Table I). This result is also in general agreement with density-gradient profiles which clearly show that the 16S and 16–4S peaks together are about three times the value of 23S.[3] However, as ultracentrifugation is unable to distinguish between 5S, 4S and free ^{32}P, density-gradient cannot give a true picture of the synthesis of the lighter RNA fraction. Thus from our earlier results[3] it could not be said whether the comparatively large peak of 4S (much larger than 23S) represented real transcription or was only due to free ^{32}P. The present method of electrophoretic separation shows clearly that in all the three stages 4S constitutes the smallest fraction. Thus it has been possible to shed light on the transcription of 4S RNA.

Unit of Embryology, R. L. BRAHMACHARY.
Indian Statistical P. K. TAPASWI.
Institute,
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RHIZOSPHERE MICROFLORA OF COFFEE PLANTS AFFECTED BY DECLINE DISEASE

A SEVERE decline disease of coffee is prevalent in Cannon Cadu Estate of the Consolidated Coffee Estates, Pollibetta, Coorg. This disease is characterized by sudden yellowing of the foliage, severe leaf shedding followed by reduced leaf size and chlorosis of new flush, poor bearing, and die-back of the twigs. Usually plants above three years of age, which bear very heavily during one or two successive crop seasons, seem to succumb to the disease. After the early disease symptoms set in the plants may take one to three years to wilt and die. The disease first appears sporadically on a few plants in the field and later spreads rapidly to cover the entire field during the course of three or four years. It is stated that various experts have examined the plants and carried out experimental studies to establish the causal agent. Though involvement of fungal and/or nematode pathogens is suspected no conclusive evidence in this regard has so far been obtained.

It was therefore considered worthwhile to approach the problem from the point of view of interaction of micro-organisms with the plant roots in the given ecosystem. Even though the micro-organisms are small they exert large effects—neutral, beneficial or antagonistic on macro-ecosystem. Hence, the activity in the rhizosphere of coffee plants as influenced by the quantity and quality of micro-organisms present therein was examined.

The last two authors visited the diseased area during September 1968 and collected soil and rhizosphere samples from healthy and diseased plants showing typical symptoms. Also, trials were laid out to examine the effect of heavy liming of the soil on diseased and healthy plants. The root zone soil of the healthy and affected plants were carefully dug out upto a depth of about 12 inch, with least damage to the roots, and 2 lb. of slaked lime powder and 2 lb. of ammonium sulphate were added per plant to cover the entire radius of plant-spread. Then the same unearthed soil was replaced and pressed. After an interval of six months representative samples of soil and rhizosphere from the healthy, diseased and treated-diseased plants were collected.

The soil and rhizosphere samples were analysed for the bacterial, actinomycete and fungal populations by the dilution plate method using soil extract agar for bacteria, rose Bengal-streptomycin agar for fungi and Kuster's agar for actinomycetes. The procedure followed for sampling and testing the rhizosphere effect was the same as that of Timonin.[1] Besides, to examine the total biological activity of the soil and rhizosphere samples, their dehydrogenase activity was estimated by the triphenyl-tetrazolium chloride method following the procedure of Casida[2] with glucose as an added metabolite.

The data presented in Table I indicate the wide variations in the bacterial populations in the rhizospheres of diseased and healthy plants. The fungal and actinomycete populations as also the dehydrogenase activity of the two samples did not vary much. Application of lime and ammonium sulphate to the soil, on the other hand, significantly increased the actinomycete and fungal populations and the dehydrogenase activity, but not the bacterial activity. The H-ion concentration of the region seems to be altered because of the diseased condition of the plant. It could also be manipulated through chemical treatments to the soil, as seen from the data obtained from treated plants.

TABLE I

A comparison of the rhizosphere microflora of diseased and healthy coffee plants

Rhizosphere soil sample	pH	Moisture %	Bacteria* $\times 10^6$	Actinomycetes* $\times 10^3$	Fungi* $\times 10^4$	Dehydrogenase* activity μl of H_2/g. soil
Healthy plant	5·0	18·99	1·08	0·35	4·8	0·30
Diseased plant	5·8	20·40	3·31	0·41	5·4	0·26
Treated plant	6·3	19·00	3·20	1·95	1·10	1·20

* Data calculated for moisture-free soil.

Studies on the types of fungi present showed that in the rhizosphere of healthy plant majority of them were of sporulating type mainly made up of *Penicillium*, *Aspergillus* and *Verticillium* and to a lesser extent *Mortierella* and *Botrytis*. In the rhizosphere of diseased plant mostly hyphal forms were found. Prominent among them were *Fusarium* and *Verticillium*. *Botrytis*, *Penicillium* and *Aspergillus* were significantly absent in the rhizosphere of diseased plants. In the rhizosphere samples from the treated-diseased plants *Fusarium* and *Botrytis* were predominant and *Penicillium*, *Aspergillus* and *Verticillium* were significantly absent. Closer examination of the bacterial population indicated that in the rhizosphere of healthy plant *Bacillus* was predominant, in the diseased plant as well as treated-diseased plant Gram-positive and Gram-variable cocccids in clusters and chains were common.

These observations indicate that the microbial population in the rhizosphere region is altered both quantitatively and qualitatively due to diseased condition of coffee plant and through fertilizer treatments to the soil the micro-organisms are altered to some extent. How far such an effect would help in preventing infections of plant roots by pathogenic organisms remains to be understood. In a recent paper Sivasithamparam[3] reported that in virus-affected *Crotolaria juncea* L. rhizosphere, there was no *Trichoderma viride* Pers. ex Fr., while the same was dominant in the rhizosphere of healthy plants. Perhaps by manipulations through soil fertilizer application and/or foliar spray we could so alter quantitatively and qualitatively the rhizosphere microflora as to give protection to the plant against infection by pathogens. More work is needed in this direction.

Dept. of Microbiology, N. R. VISHWANATH.
University of Agril. RAMACHANDRA B. PATIL.
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Bangalore-24, *July* 8, 1968.

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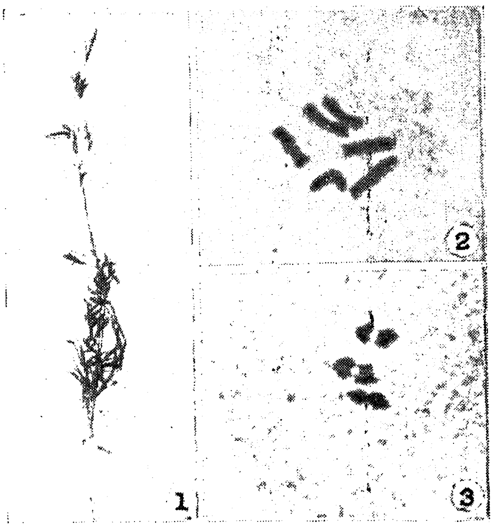
NEW BASIC CHROMOSOME NUMBER OF THREE IN GRAMINEAE (POACEAE)

BOR[1] described five species of the genus *Iseilema*, four of which are found in India and one in Burma. According to Blatter and McCann,[2] three of these four Indian species *I. anthephoroides* Hack., *I. laxum* Hack. and *I. wightii* Anderss. are found in Maharashtra State. Chromosome numbers of *I. laxum* and *I. wightii* have already been worked out by different workers. In *I. laxum* Celarier and Paliwal[3] found $n = 4$; Ramnathan[4] reported 18 and Swami[5] 12. Joshi *et al.*[6] observed that both *I. laxum* and *I. wightii* had the chromosome number of $n = 14$.

I. anthephoroides (Fig. 1) collected from the uncultivated areas of Poona had the height of 30 to 50 cm. and the hermaphrodite spikelets developed on stipes that were 0·5 mm. long. It is an annual and its voucher specimen has been deposited with Herbarium of the Botanical Survey of India, Western Circle, Poona, India (B. S. I.). Squashes of growing root tips indicated that this species had $2n = 6$ chromosomes (Fig. 2). Studies of pollen mother cells indicated that meiosis was normal as three bivalents were found at metaphase I (Fig. 3).



FIGS. 1–3. Fig. 1. Plant specimen of *Iseilema anthephoroides.* Fig. 2. Mitotic metaphase showing $2n = 6$ chromosomes, × 2,500. Fig. 3. Metaphase I with three closed bivalents.

Chromosome number of $n = 3$ has been reported for the first time in *I. anthephoroides.* It is a new basic number for the genus *Iseilema* and the entire grass family. Darlington and Wylie[7] have given 4 as the lowest basic number for the Gramineæ. In the *Index to Plant Chromosome Numbers*[8,9] and in *Taxon,*[10-14] gametic number lower than 4 has not been listed under Poaceæ.

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Cytogenetic Laboratory, RUI D'CRUZ.
Botany Section, S. P. BIRARI.
College of Agriculture,
Poona-5, M.S., India, *June* 11, 1969.

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OCCURRENCE OF *PTERYGOSOMA NEUMANNI* VAR. *HIRSTIELLI* IN AND AROUND TIRUPATI AND MADRAS

Geckobia indica and *G. gleadoviana* have been reported from *Hemidactylus gleadovi* of North India.[1,2] Three other species—*G. diversipilis, G. simplex* and *G. hindustanica*—were recorded from *Hemidactylus leschenaulti* of South India.[1,2] *P. neumanni* was reported from garden lizard (*Calotes versicolor*) of Madras.[1] Abdussalam[3] described in detail the male specimen of *P. neumanni* var. *hirstielli* from a garden lizard (Madras and Lahore). Lawrence's[4,5] was a major contribution to the host-parasite relationship in Pterygosomidæ. A recent key to the genera of the family Pterygosomidæ (Oudemans, 1910) was given by Davidson.[6]

This note reports the occurrence of Pterygosomid mites in and around Tirupati and Madras and presents a detailed description of female Pterygosomid mite. The richness of the lacertilian fauna of Tirupati makes the occurrence of Pterygosomid mites highly likely.

The garden lizard (*Calotes versicolor*) outnumbers the other variety of lizards (Sitana, Mabuya, Varanus and others). Specimens of this species were collected in large numbers from different parts of Tirupati and Madras. On close examination mites of Pterygosomidæ family were found beneath the scales from all over the body. These mites were picked up and preserved in 70% alcohol. Some were mounted in Berlese gum chloral mutant and others were cleared in lactophenol with gentle heat wherever necessary and mounted in Canada balsam for microscopic examination. Besides, visual observations were made on fluid mounts as well, and Camera lucida sketches were made.

DESCRIPTION

Female.—Body is usually much wider than long, 0·6–0·65 mm. in length, 1·0–1·3 mm. in breadth (Fig. 1, A). Reddish while alive; yellowish-brown on preservation; serrate anterior dorsal setæ form dense cluster adjacent to mouth parts extending almost to the lateral apices of the body; two pairs of mid-dorsal spiculate setæ set apart from the shoulder hairs; mouth parts short and stout; cheliceral shaft longer than the length of the swollen base of the chelicera; the fixed digit of the chelicera reduced to a weak spinous process; the movable digit twisted to project laterally (Fig. 1, B); Cheliceræ—200 to 220 μ. in length; hypostome in the form of elongated flat plate with truncated end, with serrated edge flanked on either side by a 5-segmented pedipalps; second and third pedipalpal segments with simple mid-dorsal setæ; posterior margin of the body fringed with 18 to 22 peripheral setæ of which some are fine, pointed and longer than the rest, while the others are stout spiculate and expanded; with no eyes; ventral surface with three pairs of simple fine pointed setæ.

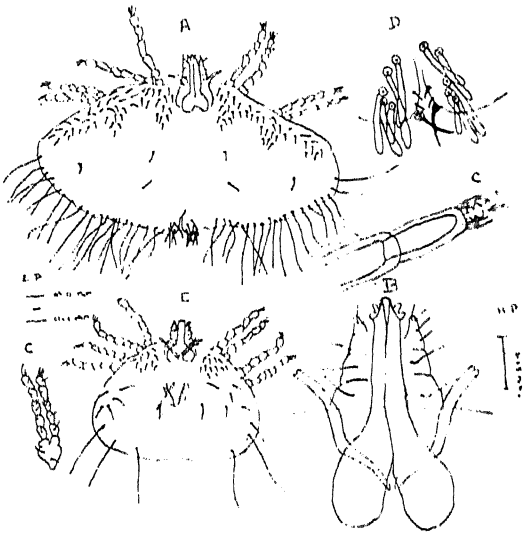

FIG. 1

Legs anteriorly directed, coxæ I and II on each side fused into a coxal plate; III and IV coxæ similarly fused into another coxal plate; each coxal plate with a pair of setæ (Fig. 1, C).

Anal field.—5 pairs of hairs in two groups an anterior group of 2 pairs and a posterior group of 3 pairs flank the anal opening; hairs expanded terminally; last pair smallest; on either side of anal opening 3 pairs of spines of which first two pairs small and last pair stouter (Fig. 1, D).

Male.—Fewer in number, smaller than the female; 0·5 mm. in length; 0·68 mm. in breadth (Fig. 1, E). Mouth parts and legs resemble those of female; dorsal surface with relatively few setæ about 20; 5 pairs of spiculate setæ lateral to dorsal setæ; 3 pairs of elongated slender pointed peripheral hairs; first two pairs situated laterally in the last 1/3 of the body; 3rd pair situated in the neighbourhood of the genital field; genital opening along mesial line a little in front of centre of the body; two prominent lips (genital cone) at the genital opening; genital cone with one pair of inconspicuous setæ; spicule 0·15 mm. long.

Our sincere thanks are due to Dr. P. S. Rajulu, Principal, College of Veterinary Science, Tirupati.

Dept. of Parasitology, P. PADMAVATHI.
College of Veterinary A. VENKATARATNAM.
Science,
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REVIEWS AND NOTICES OF BOOKS

Principles of Radiological Health. By E. F. Gloyna and J. O. Ledbetter. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1969. Pp. xviii + 473. Price $ 14.50; Sterling Price £ 6. 18 *sh.* 0 *d.*

Principles of Radiological Health presents the problems-and-applications approach toward radiation safety. The specific premise underlying the book is that the practitioner should be able to measure the radiation exposure and/or dosage; to evaluate the hazards from the radiation; to design control methods, equipment, and procedures; to institute the controls; and to check the effectiveness of the measures initiated. In order to be able to perform these actions effectively, one needs to have certain background information and theory. This book deals specifically with the problems associated with environmental radiation protection; it includes pertinent physical, chemical and biological data. Information is provided for estimation of personnel protection, and the broader aspects of environmental pollution are described.

The chapters contained in this book are: Atomic Structure; Radioactive Processes; Radiological Reaction Times; Interaction of Radiation with Matter; Radiation Dosage; Principles of Detection; Statistics of Radiation Measurement; Techniques of Measurement; Effects of Ionizing Radiations; Environmental Transport of Radionuclides; Radiation Protection Methods; Radioactive Wastes Management; X-Rays; and Hazards of Non-ionizing Radiations.

This book can be used for a first-year graduate course in radiological health. Many sections of the text can also be used by undergraduates studying environmental health engineering, industrial hygiene, and radiological health. Example problems are provided throughout and each chapter concludes with a set of practice problems. The book is also valuable to the professional working in the general area of radiation protection. It provided a reference source for public health personnel, environmental health engineers, radiological health specialists, and medical groups. It will serve as a useful reference book as well as a basic text-book. C. V. R.

The Philosophical Impact of Contemporary Physics. By Milic Capek. (D. Van Nostrand Company, Inc., New York, Toronto, London, Melbourne), 1961. Copyright. Pp. ix + 419. Price $ 8.00.

For three centuries the classical picture of the physical world dominated the imagination of physicists and philosophers. Then, within the relatively short span of the first three decades of the twentieth century, it collapsed under the impact of new discoveries. Yet, its influence was too long and too profound to disappear immediately and it continues, often in disguised ways, to shape the thought of many interpreters of contemporary physics.

This book examines each main physical concept—first in its historical setting, then in its changed or changing role in contemporary physics. The emphasis is on the close connection between physics and philosophy in both the classical and modern periods.

The author analyzes the key problem of modern physics, including the correct interpretation of the relativistic space-time; the dilemma of continuity *versus* discontinuity; the inadequacy of corpuscular models; the reinterpretation of the concept of motion; the controversy over the meaning of causality; and finally, the status of physical becoming. In his concluding chapter, "In Search of New Ways of Understanding", Dr. Capek warns against the tendency. to think in visual and macroscopic terms and urges the quest for more adequate and more flexible forms of thought appropriate to the content of modren physics. Two appendices to the paperback edition show the implications of Minkowski's formula for the constancy of the world-interval for the status of becoming in the physical world. C. V. R.

Quantum Electronics in Lasers and Masers (Vol. 31). Edited by Academician D. V. Skobel'tsyn. A Special Research Report/Translated from Russian. (Consultants Bureau, New York), 1968. Pp. v + 161.

The original Russian text, published by Nauka Press in Moscow in 1965 for the Academy of Sciences of the USSR as Volume XXXI of the Proceedings (Trudy) of the

P. N. Lebedev Physics Institute, has been corrected by the editor for this edition.

The major titles of the articles contained in this book are: Methods of Obtaining Negative Temperature States in Semiconductors, by Yu. M. Popov; Regenerative Laser Amplifiers, by N. G. Basov, A. Z. Grasyuk, I. G. Zubarev, and L. V. Tevelev; Power Pulsation Modes of Lasers, by A. N. Oraevskii and A. V. Uspenskii; Investigation of the Gas Laser, by N. G. Basov, E. M. Belenov, E. P. Markin, V. V. Nikitin, and A. N. Oraevskii; Design Problems and Investigation of the Performance of the Hydrogen Atomic Beam Quantum Oscillator, by N. G. Basov, G. M. Strakhovakii, A. I. Nikitin, T. F. Nikitina, V. M. Tatarenkov, and A. V. Uspenskii. C. V. R.

The Mutants of Maize. By M. G. Neuffer, Loring Jones and Marcus S. Zuber. (Crop Science Society of America, 677, South Segoe Road, Madison, Wisconsin 53711), 1968. Pp. vi + 74. Price not given.

The maize plant, an important food, feed, and industrial crop, has an essential function in genetic and cytogenetic studies. Many of the fundamental principles of genetics and cytogenetics have been established or substantiated through experiments with maize. The genetic characters of the maize plant serve as excellent markers for the maize chromosomes, helping to elucidate important facts applicable to many other species.

The Mutants of Maize presents a visual display of all the usable mutants of *Zea mays* L. that have been more or less definitely located to chromosome. Mutants of doubtful expression or questionable authenticity have been excluded. More than 150 four-colour photographs are used to show mutations. Precise colour fidelity has been observed in these photographs. Cytological and linkage maps and microphotographs help in visualizing the locations of the chromosomes. Four tables and a complete gene index assist the reader in using the book.

Researchers in genetics around the world will find this book useful in recognizing and classifying mutant characteristics. Botany and biology teachers and students will find these illustrations useful in laboratory studies involving maize.

The contents of this book are: 1. The Ten Chromosomes of Maize: Pachytene Photograph and Schematic Drawing; Cytological Map; Linkage Map. 2. Colour Plates of Mutants: Mapped Mutants (Chromosomes 1-10); Location to Chromosome only (Chromosomes 1-10); Location Unknown; Chromosome Abnormalities; Mutator Systems; Non-Mendelian Inheritance; 3. Interaction Tables: Anthocyanin Pigments in Aleurone Tissue; Anthocyanin Pigments in Plant Tissues; Alleles of A_1 and R_1; and Chlorophyll, Dormancy Relationships. C. V. R.

Characterization of Organic Compounds by Chemical Methods. By T. C. Owen. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1969. Pp. 247. Price $ 6.75.

This is a well-designed introductory laboratory text-book for organic qualitative analysis. The text deals with twelve most familiar functional groups, and the choice of substances is confined to those which exhibit fairly uncomplicated typical behaviour. Micro-techniques are advocated throughout. The functional groups dealt with are: Amines; Carboxylic Acids; Phenols; Aldehydes and Ketones; Esters; Alcohols; Alkenes and Alkynes; Ethers; Alkyl Halides and Aryl Halides.

The systematic treatment of the exercises is done under the following chapter heads: Introduction; Functional Group Organic Chemistry; Equipment and Techniques; Functional Group Identification; Selection and Preparation of Solid Derivatives; and Tables of Physical Properties. A. S. G.

Books Received

Catalysis Reviews (Vol. 2). Edited by H. Heinemann. (Marcel Dekker, Inc., New York), 1969. Pp. viii + 359. Price $ 17.50.

Chemists Guide—Basic Chemical and Physical Data. By J. P. Jesson and E. L. Mutterties. (Marcel Dekker, Inc., New York 10016), 1969. Pp. iii + 43. Price $ 1.95.

A Functional Bestiary Laboratory Studies about Living Systems. By Steven Vogel and Stephen A. Wainwright. (Addison-Wesley Pub. Co., London W. 1), 1969. Pp. iv + 106. Price 15 *sh.*

Symposia of the British Society for Parasitology (Vol. 7). *Nippostrongylus and Toxoplasma.* Edited by A. E. R. Taylor (Blackwell Scientific Publications, Oxford, England), 1969. Pp. vii + 75. Price 30 *sh.*

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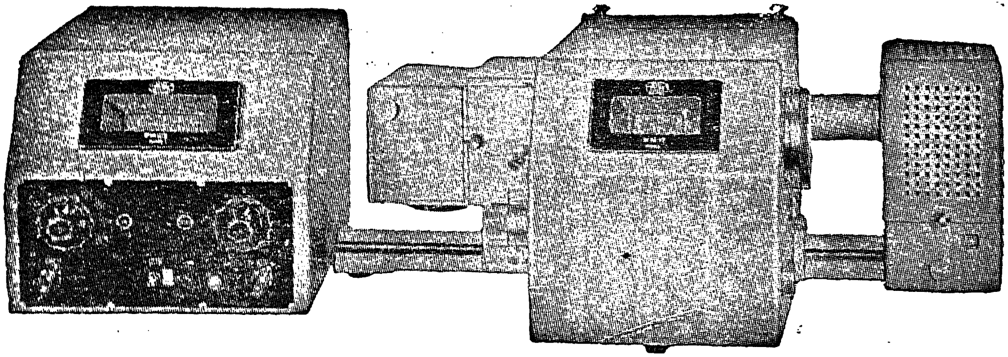

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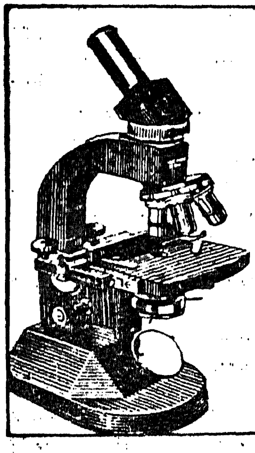

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THE COLOURS OF ROSES

SIR C. V. RAMAN

ABSTRACT

A spectrophotometer record of the absorption spectrum of an acetone extract of the pigments of a red rose is reproduced. It exhibits three peaks respectively in the yellow, in the green and in the greenish-blue regions of the spectrum, thereby indicating the identity of the pigment as Florachrome B. The features observed in the record enable it to be inferred what colours a rose would exhibit if it contained varying quantities of the pigment. These are in agreement with the facts of observation.

1. INTRODUCTION

THE popularity of the rose has led to great efforts being made towards the development of varieties exhibiting diverse habits of growth and flowering and especially those producing large blooms with numerous petals and attractive colours. Hundreds of named varieties have thus been created and widely distributed. They are to be found listed and illustrated in several publications. The colours which are forthcoming are so striking and so varied that considerable interest attaches to the problem of their origin.

The first step towards the elucidation of these colours is to classify them into distinct groups. We may begin with some familiar colours, *viz.*, yellow, orange, scarlet, red and crimson—limiting ourselves to those cases in which these colours exhibit the maximum degree of saturation or fullness. But not all roses can thus be described. Many present similarity in colour to spectral yellow, orange or red, but are of less saturated hues. Other colours, again, bear no resemblance to any of the pure spectral colours. Various special names have been given to rose colours, *viz.*, cream, pink, salmon, vermilion, mauve and lilac. To this list must be added the multi-coloured roses which display different colours on the front and reverse faces of the petals, *e.g.*, scarlet and yellow, or red and white, while others present areas different in colour on the same side of the petals.

2. THE GENESIS OF THE COLOURS

We are chiefly interested here in the chemical problem, in other words, with ascertaining the nature of the pigments present in the petals which absorb the light rays incident on them, the rays which escape such absorption and emerge as diffused light determining the observed colours. Observation of the flowers held in sunlight through a pocket spectroscope reveals that roses exhibiting vivid colours such as scarlet, red or crimson completely absorb most of the visible spectrum, allowing only limited regions of it to escape as diffused light. Similar observations with the less vividly coloured roses indicate only the parts of the spectrum which suffer the greatest measure of absorption. Thus, in either case, the information which is forthcoming does not enable any definite conclusions to be arrived at regarding the absorptive properties of the pigment over the entire range of the visible spectrum.

In these circumstances, it becomes necessary to rely on the study *in vitro* of the pigments extracted from the rose petals by solvents which do not fundamentally alter their optical behaviour. The two solvents which have been employed in the author's studies are ethyl alcohol and acetone respectively. Rose petals immersed in ethyl alcohol are bleached and given sufficient time become practically colourless. With yellow roses, or with multi-coloured roses exhibiting yellow faces or sectors, the alcoholic solution exhibits a golden-yellow colour. On the other hand, the alcoholic extract of other roses is quite colourless, from which we infer that the pigment responsible for the colour of such roses has gone into solution, but has simultaneously been transformed into a colourless product.

Rose petals immersed in acetone behave differently. Yellow roses, and the yellow areas in multi-coloured roses are not immediately affected. But roses of all other colours and the areas on multi-coloured roses exhibiting colours other than yellow are quickly decolourised, and as the pigment is extracted from the petals, it dissolves in the acetone which then acquires its colour. The acetone extract may then be transferred into an observation tube with flat ends. Viewed against a bright source of white light through a pocket spectroscope, the absorption spectrum of the solution is seen by the observer. The concentration of the acetone extract can be varied by using fewer or more petals as the case may be and adjusting the quantity of acetone used for the extraction. It is also useful to have observation tubes of greater or shorter length, as may be found desirable, depending on the strength of the coloured extract.

Observations made in this manner with the acetone extracts reveal that the extracted material is much of the same nature in all the cases which have been studied by the author. Crimson roses, red roses, scarlet roses, orange roses and roses which are a light pink or a deep pink, all present spectra which are very similar in appearance. The long wavelength region in the spectrum extending from 600 $m\mu$ upto the red end comes through in full strength. But the yellow and green sectors of the spectrum between 600 $m\mu$ and 500 $m\mu$ are strongly absorbed. Darker bands in which such absorption is a maximum are clearly visible respectively in the green and yellow parts of the spectrum. There is also an observable transmission of light in the blue region of the spectrum.

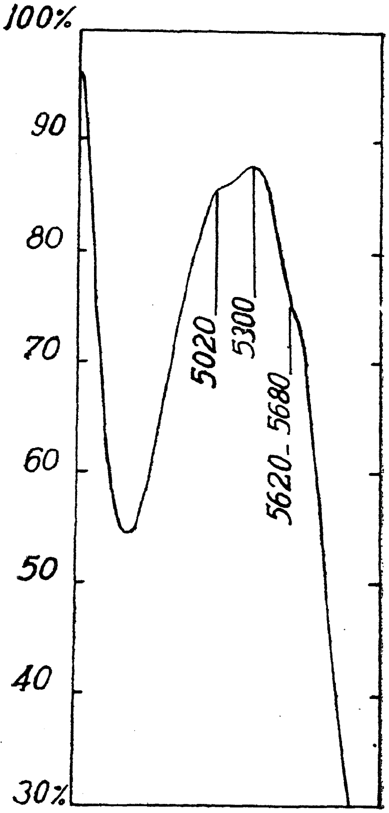

FIG. 1. Absorption spectrum of red rose.

The alcoholic extract from yellow roses examined spectroscopically exhibits an absorption which covers the short-wave end of the spectrum and extends a little beyond the blue upto about 515 $m\mu$.

3. SPECTROPHOTOMETRIC STUDY

Figure 1 is the spectrophotometric record obtained with the acetone extract from a rose of a deep red colour held in a cell of one centimetre thickness. The figures entered are wavelengths in angstroms. The extract had to be diluted with acetone to enable the nature of the absorption to be clearly recorded. It will be seen that the record exhibits three distinct humps appearing respectively in the yellow, in the green and in the blue-green regions of the spectrum. These features exhibited by the record indicate that the pigment responsible for the colour of the red roses may be identified with the material designated by the author as Florachrome B.

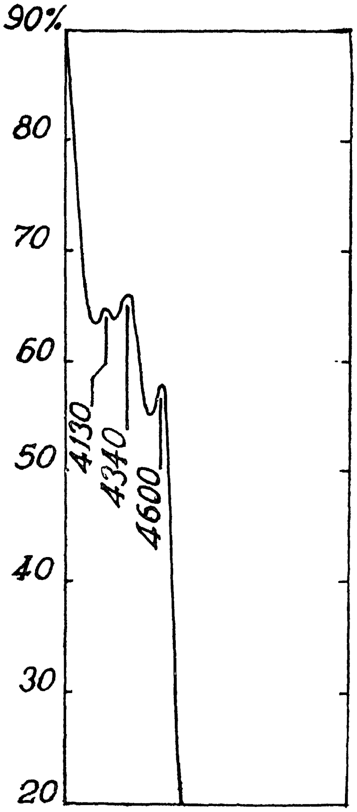

FIG. 2. Absorption spectrum of yellow rose.

Figure 2 is the spectrophotometric record of the alcoholic extract from a yellow rose. The figures entered are wavelengths in angstroms. The absorption is manifested only in the blue region of the spectrum and the three peaks which appear in the record are an indication that the pigment which gives the characteristic golden-yellow colour to the extract belongs to the well-known class of organic compounds known as the carotenoids.

4. EXPLANATION OF THE COLOUR VARIATIONS

The features noticed in the recorded curve of absorption appearing as Fig. 1 enable us to give a reasonable explanation of the great range of colours actually exhibited by roses. The factor which is different for the roses of different colour is the quantity of pigmentary material present in the petals. On the basis of such variation, it is possible to deduce the results to be expected and compare them with the actual facts of observation.

We may begin with the cases in which the pigment is present in minimal quantities. It is evident from Fig. 1 that in such cases, the absorption of light by the petals would be principally observed in the range of wavelength from 500 mμ to 550 mμ and that it would be much less both at greater and smaller wavelengths, becoming altogether insensible as we approach the red end of the spectrum. Examination of pink roses held in bright light through a pocket spectroscope discloses just such a situation. Further, it is found that the deeper the pink colour of the rose, the greater is the absorption noticeable in the green sector of the spectrum between 500 mμ and 550 mμ. But both the red and the blue regions of the spectrum persist.

We may next consider the cases in which the pigment is present in substantial quantities, sufficient to make the absorption by the petals completely effective except in the regions of the spectrum where the absorptive power is quite small. Referring again to Fig. 1, it will be seen that in such cases, the light which escapes such absorption could appear only at the extreme red end of the spectrum, and the rose would appear of a deep crimson colour. With less pigment available, wavelengths upto about 600 mμ could escape complete absorption and the colour of the rose would then be a bright red instead of a deep crimson. When the quantity of pigment available is still smaller, wavelengths between 570 mμ and 600 mμ would commence to appear in the light diffused by the petals and the colour of the rose would alter from red to scarlet. With further diminution of the quantity of pigment available, the light diffused by the petals would extend further towards still shorter wavelengths and the colour of the rose would alter from scarlet to orange. Actually, when orange roses are viewed through a pocket spectroscope, we find that the spectrum from the extreme red upto 550 mμ comes through, while shorter wavelengths are absorbed. In all these cases, the blue region of the spectrum is scarcely to be seen.

The author has not had an opportunity of examining roses which have been described as exhibiting purplish hues. If blue roses were ever forthcoming, they would assuredly exhibit the spectrum of Florachrome A, with its characteristic bands of absorption in the red, yellow and green regions.

The spectrophotometer records reproduced above were made in the Instruments Laboratory of the Indian Institute of Science, to the authorities of which the author's thanks are due.

FURTHER CHARACTERISTICS OF FLORACHROMES

M. J. NARASIMHAN JR., AND V. G. GANLA
Physiology Research Centre, B.J. Medical College and Sassoon General Hospitals, Poona, India

THE presence of floral pigments and their separation and classification into florachromes as Florachrome A and Florachrome B, have been demonstrated by Sir C. V. Raman.[1] This has been a revolutionizing concept, from the older and original concept of anthocyanin pigments, in floral pigmentation.

Recently, the characteristics of the florachromes on spectrophotometry has been demonstrated,[2] which confirms the observations presented initially.[1]

The original concept that the differences in the basic pigmentation being due to mere pH changes cannot be readily accepted because at no stage does a red flower turn blue, on carrying out finely graded stage-wise alkanisation of the environment.

Also in flowers wherein due to genetic mutation the same petal bears spots of different colours, if the changes in colour were due to pH changes, it is hard to accept how, the same sap which circulates in the interstitial spaces of the petals with the pH of the sap during its circulation through a petal being constant, the colours could be different from spot to spot on the same petal.

Also, whatever their basic chemical configurations, although these are similar as demonstrated earlier, in the exposition of the chemical characteristics of the florachromes,[1,2] their class behaviour as seen biologically and physicochemically is different which would warrant their being placed in two separate categories as Florachrome A and Florachrome B. Chromatography, which is a basic chemical technology, for differentiating substances according to their motility and R_f values confirms the previous statement.

On chromatography, using both T.L.C. and paper chromatography methods, and a solvent system of acetone : H_2O (1 : 1), which was found to be the best after trial of numerous other combinations for the selection of solvent systems, it came out that Florachrome A from blue flowers had a poor chromatographic motility, the R_f value being 0·350 to 0·355, while the Florachrome B from red flowers had a high degree of chromatographic motility, the R_f values being 0·90 to 0·96. This vast difference in the R_f values shows their difference in physico-chemical behaviour.

Furthermore, chromatography proves the presence of both florachromes in the same petal as envisaged earlier.[2] Paper chromatography (Acetone : H_2O 1 : 1) of *Thunbergia grandiflora* var violet, which shows a pinkish-blue colour, showed the presence of both the florachromes as seen by their R_f values (Fig. 1, X). This not only shows that both florachromes can exist in the same petal, but that they could be separated by chromatographic methods. This shows the definitive presence of two classes of floral pigments Florachrome A and Florachrome B, as seen by their difference in physico-chemical behaviour.

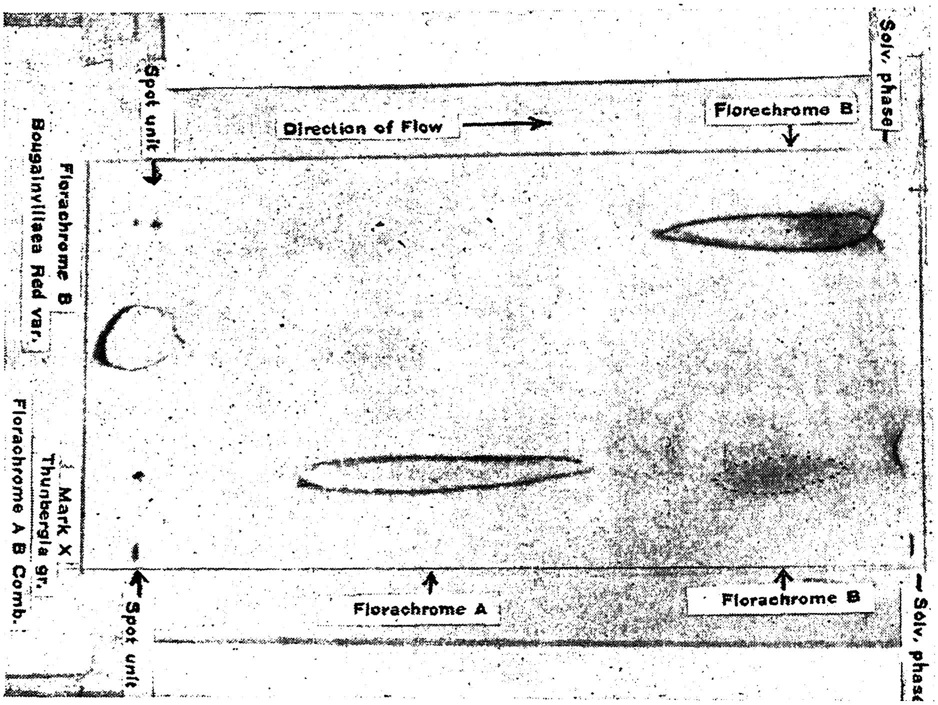

FIG. 1

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ORIGIN OF THE SUMMER MONSOON CURRENT OVER THE ARABIAN SEA

Y. P. RAO
Meteorological Office, Poona-5

AND

B. N. DESAI
173, Swami Vivekananda Road, Vile Parle (West), Bombay-56

PRIOR to 1963 it was considered on the basis of soundings over the Peninsula that the depth of the southwesterly to westerly moist current over the Arabian Sea was about 6·0 km. The International Indian Ocean Expedition results, however, showed that the depth of the deflected trades current was only 1·0 to 1·5 km. over the Arabian Sea west of about 68° E.; above this layer there was on some occasions drier unstable airmass with an inversion between the two, while on other occasions there was less moist airmass with nearly saturation adiabatic lapse with or without an inversion between the two. Further, in the former case, *i.e.*, when there was presence of drier air above the layer of the deflected trades, the depth of the moist current increased and the height of the inversion base was raised within about 500 km. of the coast as the Ghats were approached and on the west coast the moist current became about 6·0 km. deep and there was absence of inversion when the monsoon was active.[1,2]

Pisharoty[3] calculated moisture over the equator and over the west coast of the Peninsula during July 1963 and 1964 and observed that the moisture over the west coast was about two and a half times that over the equator. He suggested that the moisture was added over the Arabian Sea due to evaporation from the sea and droplet associated with the breaking waves formed due to strong winds. Pisharoty has argued that in view of moisture considerations, the south-west monsoon would appear to be primarily a northern hemisphere trade wind system blowing from the equator north-eastwards into Peninsular India rather than the deflected south-east trades of the southern hemisphere. Desai[4] has shown that Pisharoty's view is not tenable.

It is also seen from the climatological charts that during the northern summer monsoon season the mass of air of northern hemisphere origin which can move eastwards across the Somalia (north of about 8° N.) and Arabian coasts is inadequate to explain the mass of air which is transported across the west coast. Thus the origin of the westerly moist airmass over the Peninsula, when the monsoon is active or strong on the coast in terms of rainfall there, has to be sought not in the northern hemisphere but elsewhere.

In two latest papers Findlater[5] has discussed this question and come to the following conclusions:

1. A persistent high-speed air current, in the form of a system of low-level jet stream, exists in the lower layers of the air in the vicinity of the western Indian Ocean during the northern monsoon.
2. The high-speed current is an integral part of the general circulation in that season and the roots of the flow indicate that the southern hemisphere air may have different origins—either from the east of Madagascar or from near the southern tip of South Africa across Mozambique Channel; the current from the east may on some occasions be accelerated or even be temporarily replaced by the current from the south.
3. The southerly flow is accelerated into a well-defined stream which crosses the equatorial area in a limited zone of longitude, 38° to 42° E, speed being maximum near 40° E. and decreasing further west and east and becoming minimum near 70° E. The flow becomes south-westerly to the north of the equator over and off Somalia.
4. The patterns reveal that the south monsoon in the equatorial area is contained below 600 mb. level, maximum speeds of 50 to 100 kt. occurring intermittently in the layer 600 to 2,400 m.
5. Variations in the cross equatorial speed of this current were found to have an important regulating effect on the rainfall producing capacity of the south-west monsoon over India during a two-month (July-August, 1962) sample period.

The above new facts of observations would support the view of Desai[1,2] that the air from the southern hemisphere which crosses equator to the west of about 60° E. enters the Arabian Sea and constitutes the Arabian Sea Monsoon current. It should be stated that when the upper air above the surface layer of deflected trades over the Arabian Sea is less moist and has nearly saturation adiabatic lapse, it may also be the air which has moved from the southern hemisphere across the equator. On occasions when in the upper levels there is drier unstable airmass, the characteristic airmass stratification (deflected trades in the lower levels and continental air in the upper levels) has considerable rain potential under suitable conditions—the presence of the Western Ghats or convergence.[6,7]

It has been observed that westerly winds with jet speeds 50 km. or more are present on some occasions at different places over the Peninsula at 1·5 km. and even at 3·0 km. when the monsoon is active or strong on the west coast with or without a depression over the area.[1] This fact would also indicate that the origin of the strong moist westerly winds over the Peninsula might be in the southern hemisphere as hitherto believed and confirmed by the results of Findlater (1969). The mass of moist air which crosses the west coast and causes rain there would appear to depend on and to be regulated by the mass of air transported across the equator from the surface to about 4·5 km. between about 38° and 45° E.

The Arabian Sea monsoon current is thus *not* primarily a northern hemisphere trade wind system blowing from the equator north-eastwards but has its roots in the southern hemisphere and is a part of the general circulation across the equator between about 38° and 60° E. In view of this fact it would appear that if upper winds observations upto about 6·0 km. over the eastern coastal area of Africa north of about 15° S and from the western Indian Ocean islands like Mauritius, Seychelles and Moroni (Comoro Islands) and two stations near 15° S on the east and west coasts of Madagascar besides those from the eastern tip of Ethiopia and Somalia are made available in India during the months May to September, it might become possible to anticipate somewhat ahead than at present strengthening and weakening of monsoon in terms of rainfall over the west coast of the Peninsula.

---

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ON THE OCCURRENCE OF INDOLE ACETIC ACID SYNTHESIZING MICRO-ORGANISMS IN WATERS

R. RAMABADRAN, R. NARAYANASWAMI AND D. CHANDRAMOHAN

Microbiology Laboratory, Annamalai University, Annamalainagar P.O., Tamil Nadu, India

IT is well understood that plants are surrounded by large populations of micro-organisms of the atmosphere, soil and water. The influence of these organisms on the growth of the plant and *vice versa* cannot be overlooked. Studies made so far on the inter-relationships between plants and soil micro-organisms have revealed some fundamentally important information. The organisms present in the atmosphere, soil and water do influence the plant growth either directly or indirectly. Recently, Libbert *et al.*[1] reported that, the major part of the growth hormone, indole-acetic acid (IAA) present in plants, is produced by the epiphytic organisms. Later, it was also observed that the epiphytic micro-organisms present on cotton plants synthesized IAA from tryptophan[2] and many cultivated soils harboured such IAA producing micro-organisms.[3] In South India paddy is grown under wetland conditions where a column of water is maintained in the field throughout the growth period. The water components inorganic and organic do influence the plants. Hence, additional experiments were conducted to see the potentialities of different water samples to synthesize IAA and its contribution to the IAA pool in the soil.

All the water samples were collected aseptically in sterile glass bottles and the analyses were carried out immediately. 10 ml. of water samples were transferred to 250 ml. Erlenmeyer flasks containing 50 ml. phosphate buffer at pH 7·0 with 0·005 M L-tryptophan and 2·5 g. sucrose. The flasks were incubated at 26 ± 3° C. for 24 hr. in dark, and were adjusted to pH 3·0 with 2 N HCl. The solution was extracted with equal volumes of ether at 2° C. for 3 continuous times. The ether phase was flash-evaporated and the residue was dissolved in 2 ml. methanol.

The IAA in the methanol fraction was quantitatively estimated using Salper reagent.[4] The intensity of the colour was recorded in Spectronic-20 Colorimeter at 535 mμ. IAA was chromatographically separated on Whatman No. 1 filter-paper employing *n*-butanol-acetic acid-water (4 : 1 : 1) as the solvent and located by spraying with Salkowski reagent (1 ml. of 0·5 M $FeCl_3$ in 50 ml. of 5% $HClO_4$).

The bacterial, fungal and actinomycetes populations were determined by the serial dilution method, on soil extract agar, Martin's Rose Bengal agar and KenKnight's agar for bacteria, fungi and actinomycetes[5] respectively. The pour plates were incubated at room temperature and colonies were counted in a colony counter at suitable intervals.

TABLE I

Microbial population and IAA production in waters

Type of water	10^6/l. Bacteria	Fungi	Actinomycetes	IAA (mg./l.)
Tap-water	20	0·3	0·5	4·054
Tank water	310	7·5	1·0	8·108
Irrigation channel water	180	2·3	0·3	10·258
Paddy field water	90	0·8	2·0	5·297

TABLE II

Effect of antibiotics on IAA synthesis*

Treatments	IAA (mg /l.)
Irrigation channel water without tryptophan	..
Irrigation channel water + L tryptophan	10.258
Irrigation channel water + L-tryptophan + Streptomycin	5·835
Irrigation channel water + L-tryptophan + Penicillin	..
Irrigation channel water + L-tryptophan + Aureomycin	..
Irrigation channel water + L-tryptophan + Streptomycin + Penicillin	..
Irrigation channel water + L-tryptophan + Streptomycin + Penicillin + Aureomycin	..

* 0·2 ml. of 10,000 ppm./60 ml.

It is evident from Table I that IAA synthesizing ability of irrigation channel water was highest followed by tank-water, paddy field water and tap-water. Interestingly bacterial and fungal populations were higher in tank-water than the irrigation channel water. This clearly indicates that not only the quantity of micro-organisms present but also the quality of organisms play a major role in determining the IAA synthesizing ability of different water samples. Though the actinomycete population was high in the paddy field water, their role in auxin synthesis is doubtful. To see the contribution of various groups of organisms in IAA synthesis different selective antibiotics, *viz.*, streptomycin sulphate, penicillin and aureomycin were added separately and in combination and the IAA produced was determined. It is clearly seen from Table II that addition of streptomycin considerably inhibited IAA synthesis while penicillin and aureomycin individually as well as in combination with streptomycin completely suppressed the auxin production. Hence, it is concluded that major part of the IAA synthesized may be due to micro-organisms which are susceptible to such antibiotics. The significance of such finding will be valuable during these days when we are using commonly many antibiotics to control plant pathogens. Although IAA has been reported to be synthesized in soils and water, its influence on plant growth is to be established since the availability of tryptophan in soil is not ruled out.[6]

---

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LETTERS TO THE EDITOR

ON *m*-MENTH 1 (6), 3 (8)-DIENE (ISOSYLVETERPINOLENE)

m-MENTH-1(6), 3(8)-diene (Isosylveterpinolene) has not been described in literature. We report here the isolation and characterisation of this hydrocarbon which originates by dehydrohalogenation of *d*-sylvestrene dihydrochloride, adopting the following steps:

$$d\text{-Sylvestrene dihydrochloride} \xrightarrow{\text{aniline}} m\text{-Menthadienes (b.p. 69–88°/20 mm.)}$$

$$\xrightarrow[\text{Distillation}]{\text{Fractional}} m\text{-Menthadienes (b.p. 85–88°/20 mm.)} \xrightarrow[\text{Distillation}]{\text{Fractional}}$$

$$m\text{ Menthadienes (Isosylveterpinolene + sylveterpinolene) (b.p. 85–88°/20 mm.)}$$

$$\xrightarrow[\text{Acetone}]{\text{Maleic anhydride}} \text{Isosylveterpinolene}$$

The n.m.r. spectrum of isosylveterpinolene showed a multiplet at δ 5·33 (1 H), a broad singlet at δ 2·29 (2 H), a multiplet at δ 1·83–2·31 (4 H) and a singlet at δ 1·51 (9 H); one methylene group was more deshielded than the other two methylene groups. These data are in accord with the formula *m*-menth-1(6), 3(8)-diene for isosylveterpinolene.

Following the procedure of Chabudzinski,[1] dehydrohalogenation of *d*-sylvestrene dihydrochloride with aniline gave a hydrocarbon mixture in 77·7% yield. By fractionation in Todd Assembly at 20 mm. and reflux ratio 25 : 1, this was divided into three cuts: (*a*) b.p. 69–77°, 56%; (*b*) b.p. 77–85°, 13·9%; and (*c*) b.p. 85–88°, 26·2%. Fraction (*c*) was redistilled at a reflux ratio 50 : 1 and the portion boiling at 87–88°/20 mm. was collected, yield: 6·43%, n_D^{20} 1·5074, d_{32}^{32} 0·8612 and $(\alpha)_D^{32} \pm 0°$ ($CHCl_3$, c 6·68). A three-fold processing of this oil with maleic anhydride in presence of acetone on the lines recommended for α-phellandrene by Birch[2] afforded isosylveterpinolene, yield: 18·3%, b.p. 87–88°/20 mm., n_D^{20} 1·4881, d_{24}^{24} 0·9088, $(\alpha)_D^{24} \pm 0°$ ($CHCl_3$, c 4·04) and n.m.r. spectrum (CCl_4): as described above.

Isosylveterpinolene furnished a tetrabromide, m.p. 127–128° (decomp.), dihydrochloride m.p. 53° and dihydrobromide, m.p. 48–49°; the melting points of the dihydrohalides were undepressed on admixture with the corresponding carvestrene derivatives.

All the compounds described gave satisfactory elemental analyses.

We are grateful to Dr. G. S. Sidhu and Dr. G. Thyagarajan for the n.m.r. data. One of us (N. V. M.) wishes to thank the Council of Scientific and Industrial Research, New Delhi, for the award of a Junior Research Fellowship.

Dept. of Chemistry, N. V. MURALEEDHARAN.
Christian Medical College, J. VERGHESE.
Vellore, *June* 27, 1969.

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THERMODYNAMICS OF THE SYSTEM BENZENE + p-DIOXAN

EXCESS molar volume, V^E and excess isothermal compressibility, k_T^E, of the system benzene + *p*-dioxan was determined at 25° C. from a study of the ultrasonic velocity (C), density (ρ) and molar heat capacity (C_p) of the pure components and their equimolar solution. The results are discussed in light of the statistical thermodynamical theory of liquid mixtures due to Flory.[1]

Ultrasonic velocities were determined with an error of ± 0·01% using an interferometer, working at 3 MHz. The errors due to diffraction were corrected according to the method previously suggested by the authors.[2] Densities of the pure components were determined using a pycnometer with a probable error of ± 0·001%. The excess molar volume of the equimolar solution was determined using a dilatometer[3] with a probable error of ± 0·002 ml. Heat capacities, determined by using a specially designed calorimeter,[4] are reproducible with an accuracy of ± 0·3%. The error in the evaluation of the isothermal compressibility is ± 0·15%.

Properties of the pure components and the excess functions of the system are given in Table I.

TABLE I

Thermodynamic properties of the system benzene + p-dioxan at 25 ± 0·01° C.

Mole fraction of dioxan / Property		0	0·5	1·0
V (ml./mole)	..	89·429	87·528	85·752
C (m./sec.)	..	1297·8	1320·9	1344·4
C_p (cal./mole/deg.)	..	32·47	34·64	35·34
$k_T \times 10^4$ (ml./cal.)	..	40·10	35·01	31·55
$k_T^E \times 10^4$ (ml./cal.)	..	..	− 0·91	..
V^E (ml.)	..	..	− 0·065	..

According to Flory[1], k_T^E is given by

$$k_T^E = \frac{3\tilde{V}^2}{P^*[(\tilde{V}^{\frac{1}{3}} - 1)^{-1} - 3]} - \frac{1}{\tilde{V}}(\phi_1 \tilde{V}_1 k_{T1} + \phi_2 \tilde{V}_2 k_{T2}) \qquad (1)$$

and

$$P^* = \phi_1 P_1^* + \phi_2 P_2^* - \phi_1 \theta_2 X_{12}$$

where $\tilde{V}$, $\tilde{V}_1$, $\tilde{V}_2$ are the reduced volumes of the mixture and the pure components; P^*, P_1^*, P_2^* are the characteristic pressures of the mixture and pure components; ϕ_1 and ϕ_2 are the segment fractions. All these factors could be evaluated using the experimentally determined thermal expansion coefficient, molar volume, isothermal compressibilities (k_{T_1} and k_{T_2}) of the pure components. The contact interaction term $\theta_2 X_{12}$ can be evaluated using one of the known experimental excess quantities. In the present investigation excess volume was used to evaluate the above term. The value of − 0·64 units for the excess isothermal compressibility, calculated using equation (1), is in reasonable agreement with the experimentally observed value of − 0·91 units given in Table I. It may be mentioned that the average potential model could not predict even the sign of the excess function for this system while Flory's theory is able to predict excess compressibility correctly.

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5-NITRO-SALICYLIC ACID AS A REAGENT FOR THE COLORIMETRIC DETERMINATION OF URANIUM

SALICYLIC ACID, sulphosalicylic acid[1] and salicylamide[2] were found to give colour reactions with hexavalent uranium and have been conveniently employed for its detection and estimation. 5-Nitro-salicylic acid produced a deep yellow coloration with uranium; it was, therefore, thought that this acid might prove a useful reagent for uranium and an investigation of the system, uranyl acetate and this acid, was made.

Aqueous solutions of uranyl acetate (0·00166 M) and 5-nitro-salicylic acid (0·00166 M) reacted to yield a deep yellow colour. The maximum intensity of colour was developed at pH 8·4 and showed maximum absorption at 485 mμ. All subsequent measurements were therefore made at pH 8·4 and 485 mμ. There was little change in optical density of the solutions even after 48 hours and also even after heating to about 60° C. The composition of the complex was determined by Job's, molar ratio and slope ratio methods and was found to be 1 : 2 between UO_2^{++} ion and the reagent.

$$UO_2(CH_3COO)_2 + 2\,HR^- \rightleftharpoons UO_2R_2 + 2.CH_3COOH$$

where HR^- stands for the anion $NO_2.C_6H_3OH.COO^-$.

The dissociation constant of the complex, from molar ratio method, was calculated to be $1 \cdot 23 \times 10^{-9}$.

The system obeys Beer's Law over a concentration range of 7·14 to 120·0 ppm uranium. Sensitivity was found to be 0·12 γ U/CC.

Most of the common cations and anions interfere with the determination excepting a few like Na^+, K^+, NH_4^+, Cl^-, NO_3^- and SO_4^{2-}, which do not interfere even at relatively very high concentrations. Anions like phosphate, fluoride, oxalate, borate, citrate, tartrate, etc., interfere even when present in small amounts. A previous separation of uranium from the interfering ions is therefore necessary.

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AMPEROMETRIC DETERMINATION OF Tl (I), Co (II), Bi (III), Se (IV) AND Te (IV) WITH METHYLDITHIOBIURET

IN the amperometric procedures reported for the determination of thallium,[1-4] cobalt,[5-7] bismuth,[8-11] selenium[12,13] and tellurium,[14,15] the titrations have been carried out at a potential corresponding to the reduction wave of the cation concerned. It may be pointed out that an electro-active organic compound which is capable of forming an insoluble precipitate with these cations may serve as a potential titrant in their estimation. In this connection the use of methyldithiobiuret as an analytical reagent for the quantitative estimation of Tl^+, Co^{2+}, Bi^{3+}, Se^{4+} and Te^{4+} in micro-quantities has been investigated and described in this communication. The polarographic characteristics of methyldithiobiuret revealed a well-defined anodic wave in various base electrolytes of different pH values (4·5–12·5). The anodic diffusion current was found to vary linearly with the concentration of the compound over a limited range. Preliminary observations also showed that under regulated conditions of base electrolyte concentration and pH, the reagent reacted with these cations to give characteristic precipitates. These observations paved the way to the estimation of micro-quantities of these cations by the amperometric titration procedure. The appropriate operative conditions for the quantitative estimation were established by trial experiments. These are as follows:

Thallium.—Thallium was estimated by titrating in 0·1 M potassium nitrate + 0·1 N sodium hydroxide base electrolyte.

Cobalt.—Within 0·02 to 0·05 M overall concentration of base electrolyte (ammonium chloride and/or ammonium nitrate) and pH 9·0 to 10·0 (adjusted with ammonia) satisfactory results were obtained.

Bismuth.—Bismuth can be estimated in an ammoniacal medium consisting of ammonium tartrate and potassium nitrate (overall concentration 0·05 M) within the pH range of 8·5–10·0.

Selenium.—Reproducible results were obtained when selenium was titrated in an acetate buffer (ammonium acetate + acetic acid) and pH maintained within 4·0–5·0.

Tellurium.—Satisfactory results were obtained with the overall concentration of the base electrolyte (borax + potassium nitrate) maintained within 0·025–0·05 M and pH adjusted between 9·5–10·0 (with ammonia).

The applied potential (— 0·1v *vs.* S.C.E.) was such that the metal ion concerned was not reduced but the reagent yielded the diffusion step. The titration therefore involved the measurement of the anodic current of the excess titrant only after complete precipitation. Reverse L-shaped curves were obtained by plotting these readings against the volume of the titrant and the end-point was located graphically.

Stock solutions of various metal ions were prepared from E. Merck's guaranteed reagent grade samples. The method of successive dilution was used to obtain solutions of desired strength.

0·01 M methyldithiobiuret solution was obtained by dissolving 0·1492 g. of pure recrystallised sample in 100 ml. water. Titrations were carried out at the rotating platinum electrode. A manual unit as described by Kolthoff[16] was set up. pH measurements were made with the Beckman Zeromatic pH meter.

In a series of experiments an aliquot of the unknown solution of the cation was taken in a beaker containing appropriate base electrolyte. The pH of the medium was adjusted to the desired value. A rotating platinum electrode with S.C.E. was used and titration carried out at the potential (— 0·1v *vs.* S.C.E.) corresponding to the anodic diffusion step of the titrant. A 2 ml. microburette was used to deliver the titrant in small portions and the galvanometer reading noted after each addition. Current remained steady till the precipitation is complete and increased with excess reagent. The end-point was located graphically as the point of intersection of two straight lines. Data obtained under these conditions showed that micro-quantities of the above cations could thus be estimated accurately. These results are presented in Table I. It may be noted that the procedure is simple, less time-consuming and easily adoptable.

TABLE I

Amperometric determination of various cations with methyldithiobiuret

Cation	Amount taken mg.	Amount found mg.	Difference mg
Tl (I)	0·816	0·822	+0·006
	1·428	1·432	+0·004
	1·836	1·844	+0·008
	2·040	2·044	+0·004
	3·060	3·070	+0·010
Co (II)	0·236	0·236	..
	0·354	0·352	−0·002
	0·472	0·465	−0·007
	0·708	0·713	+0·005
	0·826	0·820	−0·006
Bi (III)	0·418	0·412	−0·006
	0·836	0·828	−0·008
	1·045	1·060	+0·015
	1·254	1·240	−0·014
	1·672	1·672	..
Se (IV)	0·118	0·117	−0·001
	0·197	0·197	..
	0·276	0·276	..
	0·395	0·398	+0·003
	0·474	0·473	−0·001
Te (IV)	0·127	0·127	
	0·254	0·256	+0·002
	0·445	0·451	+0·006
	0·635	0·641	+0·003
	0·762	0·769	+0·007

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Banaras Hindu Univ., R. K. NANDI.
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O^{18}/O^{16} AND C^{13}/C^{12} VARIATIONS IN THE LIMESTONE FROM CALC-ZONE OF PITHORAGARH

THE variations in the δO^{18} and δC^{13} values in minerals and rocks depend upon the temperature of deposition and the environmental conditions (Craig, 1953; Clayton *et al.*, 1968). Other factors such as incorporation of biogenic carbon and assimilation of carbon dioxide by green plants cause fractionation in δC^{13} values. In this communication, the δO^{18} and δC^{13} values for limestones from Calc-zone of Pithoragarh District, U.P., has been determined in order to get the information regarding the conditions of deposition of the limestones.

The carbonate samples have been decomposed with 100% phosphoric acid according to the method described by McCrea (1950) and Sharma *et al.* (1969). Carbon dioxide liberated according to the reaction:

$$CO_3^{=} + 2H^+ = CO_2 + H_2O$$

has been purified and analyzed for O^{18}/O^{16} and C^{13}/C^{12} ratio measurements on a 6″-60°-RMS-19 double collecting isotope ratio mass-spectrometer. The reported values are corrected for valve mixing and C^{13} (or O^{17}) variations according to the equations given by Craig (1957).

A brief account of the geological information of the Calc-zone of Pithoragarh (Misra *et al.*, 1961; Valdiya; 1969) is given on next page.

The δO^{18} and δC^{13} values of the samples and their locality are shown in Table I.

TABLE I

δO^{18} and δC^{13} values of the limestones*

Sample No.	Locality and Formation	δO^{18} vs. SMOW	δC^{13} vs. PDB
Pit 1 ..	Chandaak, Gangolihat, Dolomites	18·97	−0·08
Pit 2 ..	Bajer, Gangolihat, Dolomites	19·22	+0·83
Pit 3 ..	Dewalthal, Gangolihat, Dolomites	19·03	+1·15
Pit 4 ..	Pali (Ramganga Valley), Thalkedar limestones	20·85	+3·80

* The isotopic data are reported in δ terminology defined as:

$$\delta\ ‰ = \left(\frac{R_{sample}}{R_{standard}} - 1\right) \times 1000$$

where R represents O^{18}/O^{16} or C^{13}/C^{12} ratio.

The δO^{18} values are lower than the normal marine carbonates. The lower value may be due to change in environmental conditions. The presence of magnesite in this area indicates that the original marine carbonate has

Gangolihat Dolomites	Purple tuffaceous phyllites interbedded with sandy limestones; Massive, cherty dolomites with subordinate Calc-phyllites and slates; Stromatolite-bearing dolomitic limestones (biothermal) with lentiform deposits of coarsely crystalline magnesite.
Sor Slates	Olive-green, brown, grey and black slates with subordinate limestones. A prominent member of protoquartzites.
Thalkedar Limestones	Cherty dolomites and dolomitic limestones with subordinate Calc-slates and slates.
Rautgara Quartzites	Brown and greyish-pink 'protoquartzites with purple, olive-green and brown slates.

been altered due to exchange with the surroundings and hence the measured δ values have deviated from the normal marine carbonates. The variation in δC^{13} values can be explained on the basis of environmental conditions. The δC^{13} values for Pits 1 to 3 are in the range of normal marine carbonates. The high δC^{13} value for Pit 4 may possibly be due to local conditions in which the $C^{12}O_2$ has been preferentially taken by green plants so that the precipitated carbonate becomes enriched in C^{13} content.

Department of Chemistry, G. C. PANDEY.
Indian Institute of Technology, T. SHARMA.
Kanpur,
and
Department of Geology, R. C. MISRA.
University of Lucknow,
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HIGH-GRADE METAMORPHITES OF SADA—SIGNIFICANCE OF SPINEL

THE rock formations at Sada, Eastern Ghats (latitude 83° 3′ 14″ and longitude 18° 1′ 24″) essentially consist of calc-granulites, khondalite group of rocks and charnockite group of rocks. The felsic and intermediate type of charnockites occur interbedded with khondalites. Garnet-biotite-sillimanite gneisses and garnet-biotite-gneisses represent the khondalite group. Garnetiferous quartzites also occur in the sequence.

This particular study is made in a railway tunnel (No. 28) and open cut made at right angles to the NE-SW trend of the formations. A shear zone trending NE is located and is characterised by mylonites and retrograde gneisses. The mineral assemblages represented at Sada indicate the grade of metamorphism to be granulite facies. The P-T conditions of metamorphism for these high-grade assemblages at Sada are around 600° C. and above 5 Kb. The fact that cordierite-bearing gneisses are not observed in this area, places the lower limit of pressure at 5 Kb (Turner, 1968). The temperature is arrived at, based on coexisting feldspars. A little to the north of this area, cordierite-bearing gneisses are recorded. These are not however observed in the sequence at Sada.

In all these assemblages at this particular locale, spinel is an important accessory and is present in amounts upto a maximum of 4%. It is deep green, isotropic pleonast and occurs as irregular-shaped granules averaging 0·1 mm. in diameter. They are generally enclosed in garnet, magnetite and biotite. Spinel is also found in hypersthene of the charnockite assemblages. At some places, granular complexes consisting of magnetite and spinel are observed. It is significant to note that spinel is not recorded in calc-granulite assemblages.

Spinel is regarded as one of the essential phases of silica-deficient rocks belonging to granulite facies. Spinel may even appear in quartz-bearing assemblages under exceptional conditions. Spinel minerals do not figure among the normal regional metamorphic assemblages of the argillaceous sediments proper. They are recorded in certain bedded deposits of aluminum, iron and manganese ores containing little or no silica.

Eskola (1961) records on the granulites of Lapland that "During the orogenesis certain particular zone of the formation was subjected to a very strong shearing movement, as a result of which the water present was driven out, the cordierite and biotite were decomposed, sillimanite, garnet, rutile and spinel were formed, and quartz, feldspar wear out to platy grains".

The formation of spinel in calc-silicate rocks is generally attributed to contact metamorphism. The calc-silicate rocks are in association with charnockites but no spinel is found in them at Sada. Thus this could be attributed to regional metamorphic conditions involving a non-igneous phase in pre-metamorphic state.

The paragenesis of spinel in Sada appears to follow the lines outlined by Eskola (1961) involving shearing. The shear zones at Sada (Rau and Rao, 1968) and the recorded retrogressive nature in the accompanying gneisses further support this view. This also accounts for the absence of cordierite-bearing gneisses at Sada while they are recorded further north.

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Andhra University, G. Krishna Rao.
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OPISTHIOGLYPHE ENDOLOBA (DUJARDIN, 1845); A PARASITE OF THE FROG, *RANA ESCULENTA* IN IRAQ

Several specimens of this trematode were collected by one of us (M. A. R.) on several occasions during 1966 and 1967 from the small intestine of the frog, *Rana esculenta* caught from different localities in Basrah, Iraq. Most of these frogs were infected with the trematode, infection being confined to the anterior part of the small intestine. When fresh intestines were dissected out and examined under a binocular microscope, the trematodes were found to be attached to the villi by their oral suckers. Once the infested gut is transformed into a saline solution, the trematodes freed themselves and started to move very sluggishly in the solution.

Collected trematodes were fixed under slight pressure of a coverslip in 70% alcohol and permanent preparations were then made in the usual way using Gower's carmine and acetic acid-alum carmine stains.

Morphology.—The body is elongated, dorso-ventrally flattened, tapering slightly at the anterior end whereas the posterior end is truncated. It varies in length from 0·72 to 1·06 mm. (0·96 mm.)* with a maximum breadth of 0·28–0·39 mm. (0·35) attained at the testicular region. The body is armed with fine, backwardly directed cuticular spines. These spines are more numerous at the anterior end of the body, but totally absent in the post-testicular region of the parasite.

The oral sucker is slightly subterminal measuring 0·12–0·16 mm. (0·14) in its greatest diameter. The ventral sucker is smaller; it lies at the beginning of the second third of the body, and measures 0·07–0·10 mm. (0·08) in its greatest diameter.

The mouth leads into a short prepharynx and then through a small pharynx into the oesophagus. The prepharynx and the oesophagus are 0·015–0·071 mm. and 0·07–0·09 mm. in length respectively, whereas the pharynx is 0·656–0·717 mm. in greatest diameter. The oesophagus bifurcates immediately in front of the ventral sucker to form the two intestinal crura which run posteriorly to terminate blindly at the posterior end of the body.

There are two testes lying in the posterior half of the body between the two intestinal crura. They are obliquely tandem, one lying posterior to the other. They are almost equal in size and each of them is more broad than long measuring 0·12–0·13 mm. × 0·08–0·09 mm.

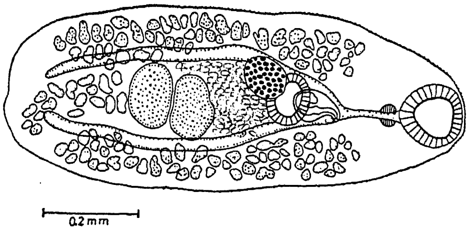

FIG. 1. *Opisthioglyphe endoloba* (Dujardin); Ventral View.

The cirrus pouch is large, pear-shaped and lies in the region of the intestinal bifurcation. It extends posteriorly to overlap the anterior border of the ventral sucker. It measures 0·11 × 0·08 mm. The cirrus pouch opens to the exterior together with the uterus by the genital pore which lies laterally to the left of the median line immediately posterior to the intestinal bifurcation.

The ovary is spherical or oval. It is smaller than the testes and lies postero-lateral to the ventral sucker. In all the trematodes examined, the anterior part of the ovary overlapped the latero-posterior edge of the acetabulum. It measures 0·09–0·10 mm. in diameter.

The vitellaria are in the form of two lateral groups of vitelline follicles. Each group extends on one side of the body from the level of the intestinal bifurcation to the posterior extremity of the intestinal crura. Moreover, there is a group of vitelline follicles which lies in the inter-cæcal region posterior to the testes.

The uterus is not large and generally occupies the whole space included between the testes and the ventral sucker. In few specimens the uterus reaches the level of the posterior testis. In fully mature specimens, the uterus is closely packed with a large number of small oval, non-operculated eggs. These eggs measure 0·043–0·052 mm. × 0·022–0·028 mm.

Relationships.—*Opisthioglyphe endoloba* was originally described as *Distomum endolobum*.[1] In 1894, this species was considered as a synonym of *Fasciola ranæ* Froelisch which was considered as a type species of the genus *Opisthioglyphe* Looss.[2] Recently, Dollfus,[3] after examining a large number of *Opisthioglyphe* sp. collected from *Rana esculenta* in Europe and *Rana ridibunda* in Morocco, concluded that these forms were identical with those described by Dujardin as *D. endolobum* (by now *O. endoloba*) which he believed to be quite distinct from *O. ranæ*. Later, *O. endoloba* was recorded from *Rana esculenta* from Iran.

It is quite evident that the trematode described in the present paper is *O. endoloba*. The present authors also agree with Dollfus's opinion regarding the separation of *O. ranæ* and *O. endoloba*. Although the two species are very similar morphologically and have the same host's range and geographical distribution yet they can be clearly separated on the basis of certain distinct characters.[4] The presence of *O. endoloba* in Iraq is a new locality record for this species which apparently has a wide geographical distribution.

Department of Zoology, M. F. A. SAOUD.
Univ. of Khartoum, Sudan,
and
Department of Zoology, M. A. ROSHDY.
Faculty of Science,
Ain Shams University,
Cairo, U.A.R., *July* 22, 1969.

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FREQUENCY OF *BRUCELLA* BLOCKING ANTIBODIES IN THE HUMAN POPULATION OF JABALPUR CITY (MADHYA PRADESH)

BLOCKING antibodies interfere with the demonstration of agglutinins in serum of undulent fever patients. Thus Standard Tube Test (STT) results often fail to give unequivocal interpretation. Direct Blocking Antibody Test (BAT) of Griffitt's[3] is capable of detecting more than 60% of infected cases where serological findings are negative (Renoux and Alton[6]; Renoux *et al.*[7]).

There is no mention of occurrence of blocking antibodies in the serological testing, reported so far in India. The incidence of blocking antibodies in cosmopolitan population of Jabalpur is being reported in the present communication.

Serum samples from 292 patients showing pyrexia of unknown origin, including those suspected for typhoid fever, brought to the Pathology Department of Medical College, Jabalpur, were selected for this study. Out of these 196 STT negative samples were tested for Direct BAT.

The technique of testing of serum samples was that of Stableforth.[8] Twofold serial dilutions of each serum in 0·5 ml. quantity were made in 5% carbol saline upto the final dilution of 1 : 640. Equal quantity of plane *Brucella abortus* antigen obtained from I.V.R.I., Izatnagar, was then added and the tubes were incubated at 37° C. for 24 hours. In samples showing no agglutination reaction, 0·02 ml. of *Brucella abortus* positive serum-containing 100 Iu/ml. antibodies was added in each dilution. The tubes were reincubated at 37° C. for 24 hours before observing the reaction. The results are indicated in Table I.

TABLE I

Particulars		No. of sera tested	No. positive	% of positive reaction
Men	..	114	8	7·02
Women	..	63	5	7·84
Unclassified	..	19	1	5·26
Total	..	196	14	7·14

As indicated from Table I the percentage of blocking antibodies was nearly the same in males (7·02%) and females (7·84%). The overall incidence of blocking antibodies was found to be 7·14%. In all positive cases the titre recorded was upto 80 Iu/ml. The lower percentage of BAT positive cases might be due to pyrexia of other origin than *Brucella* 5% Carbol-saline used in this study did not suppress the blocking antibodies. Similar observation was also made by Zinnemen *et al.*[10] and Parassit[4] and is contrary to the observations of Renoux,[5] Biggi,[2] Wilson and Miles[9] and Alton and Jones.[7]

More cases could possibly have been detected by testing sera with the more sensitive indirect Coomb's test. Nevertheless, in the present investigation comparatively slightly less sensitive direct BAT of Griffitt's due to its simplicity and relative ease of practical utility in mass application is preferred.

In doubtful cases BAT is recommended before they are classified as serologically negative for brucellosis; this is particularly more desirable in chronic cases.

Our sincere thanks are due to Dr. B. S. Malik and Dr. I. C. Dutta for their suggestions in preparing the manuscript and to Dr. R. L. Kaushal, for the encouragement given. The assistance received from Dr. P. S. Manjrekar and Dr. V. N. Gandaguli of Medical College, Jabalpur, in collecting material, is thankfully acknowledged.

Department of Bacteriology, J. L. SONI.
College of Veterinary P. N. PATHAK.
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IAA SYNTHESIS IN PADDY SOIL AS INFLUENCED BY AMMONIUM SULPHATE FERTILIZATION

HEAVY doses of fertilizer application is being adopted in recent years in India to grow high-yielding crop varieties like IR. 8 paddy. Little information is available on the effect of heavy doses of fertilizer application to the soil, on the rhizosphere microflora and indole acetic acid (IAA) metabolism in soil. Libbert and his associates[1] claimed that IAA in the plant is actually contributed by the micro-organisms, particularly bacteria present near the root system. Chandramohan and Mahadevan[2] reported that the IAA synthesising ability of soils considerably differed. In the present study attempts were made to understand the influence of high doses of nitrogen fertilizer (as ammonium sulphate) application to the soil, along with constant doses of phosphate and potash, on the microflora of soil and IAA metabolism in the rhizosphere of paddy variety IR. 8.

Keeping P (as superphosphate) and K (as muriate of potash) constant, ammonium sulphate was applied on hectare basis at different doses as follows:

C — No fertilizer (uncropped)
N_0 — 30 kg. of P + 30 kg. of K + 0 kg. of N
N_1 — ,, + ,, + 40 kg of N
N_2 — ,, + ,, + 80 kg. of N
N_3 — ,, + ,, + 120 kg. of N
N_4 — ,, + ,, + 160 kg. of N

The samples of rhizosphere and root-free soils from various treatments were collected from 0–6 inch depth in the vegetative stage of crop growth. The microbial populations were estimated by the procedure of Timonin.[3] Soil extract agar was used for estimating bacteria and actinomycetes and potato dextrose yeast extract agar for fungi.

For IAA estimation, 25 g. of rhizosphere/root-free soil samples were transferred to 500 ml. Erlenmeyer flasks containing 100 ml. of phosphate buffer at pH 7·0 with 0·005 M DL-tryptophan and 5·0 g. of sucrose. The flasks were incubated in dark at 26 ± 3° C. for 24 hr., filtered through Whatman No. 42 filter-paper and 50 ml. of the filtrate was adjusted to pH 3·0 with 2 N HCl and IAA was extracted with peroxide-free ether.[4] IAA in the extract was quantitatively estimated by employing the Salper reagent.[2,5] 100 μl of the extract was spotted on paper chromatogram and developed in *n*-butanol-acetic acid-water (4 : 1 : 1). The IAA in the extracts was identified by Co-chromatography with authentic IAA and matching colour reactions with Ehrlich and Salkowski reagents.[6]

It is evident from Table I that the microbial population and the IAA synthesizing ability of rhizosphere soil samples varied with different levels of ammonium sulphate. In general, the fertilizer treatment increased the total microflora and IAA in the soil compared to the uncropped soil. Increase in bacterial, fungal and actinomycetes populations was recorded in N_1, N_2 and N_3 treatments. However, a decline in the said microbial population was noticed in N_4 treatment.

TABLE I

Microbial population and IAA synthesis in rhizosphere and root-free soils of paddy at varied levels of ammonium sulphate application

Microbial population (10^6/g. soil)

Soil type	Bacteria	Fungi	Actino-mycetes	IAA (mg./g.)
Root-free soil (No fertilizer) ..	60	0·30	0·05	0·0337
Rhizosphere soil (0 kg N/ha.)	80	0·50	0·08	0·0959
,, (40 ,,)	95	0·72	0·20	0·0976
,, (80 ,,)	115	0·80	0·22	0·0991
,, (120 ,,)	120	0·85	0·26	0·1031
,, (160 ,,)	75	0·42	0 09	0·0741

Soil amendments with fertilizers are known to influence directly the microbial population.[7,8] All the fertilizer treatments in the present studies have significantly increased the microbial population and IAA synthesizing ability of rhizosphere soils as compared to uncropped soil. However, in N_4 treatment microbial population and IAA concentrations were reduced. Such depressive effect on microbial population at higher doses of fertilizer application has been reported by several workers.[9,10] Increased nitrogen content in plant parts due to increased levels of ammonium sulphate application leading to increased growth rate with enlarged root system might result in increased root exudations in rhizosphere region, leading to a stimulating effect on microbial population in the vicinity of root region. A conclusion is reached that the soil microflora is potentially capable of producing appreciable amounts of auxin under natural conditions.[11] Higher concentrations of IAA in various treatments when compared to uncropped soil might be due to intense proliferation of IAA synthesizing micro-organisms in rhizosphere region.

The significance of IAA metabolism in rhizosphere region deserves some attention. Nevertheless, so far as we are aware, this is the only instance in which it has been possible to demonstrate a correlation between IAA metabolism and rhizosphere microflora at varied levels of fertilizer application. The problem therefore deserves a more detailed investigation.

We are thankful to Dr. N. N. Prasad for his help.

Division of Microbiology, R. NARAYANASWAMI.
Faculty of Agriculture, V. VEERRAJU.
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AN ANTIBACTERIAL ANTIBIOTIC FROM *ASPERGILLUS CHEVALIERI*

MANY species of *Aspergillus* have been found to produce antimicrobial agents. The culture broth of *A. chevalieri* var. *intermedius* has been reported to be effective against bacteria.[1] In 1965, gliotoxin has been reported to be produced by *A. chevalieri*.[2] During the course of experiments on mutation,[3] we have come across an antibacterial antibiotic produced by *A. chevalieri*. The fungus, when grown in Czapek-Dox medium with 20% glucose, pH adjusted to 6·2 before sterilization and incubated at 30° C. produced the antibiotic which reached a peak concentration on the 7th day. The active principle was extracted from the culture broth with ether. Evaporation of the solvent yielded an orange-coloured, microbiologically active material.

This material was compared with an authentic sample of gliotoxin on one-dimensional descending paper chromatogram with a solvent system of butanol-acetic acid-water (4 : 2 : 1). Gliotoxin had R_f 0·75 and the antibiotic produced by this strain of *A. chevalieri* had R_f 0·8. A comparison of the antimicrobial activities of both the antibiotics was carried out using the agar-cup method of assay (Table I).

TABLE I

Comparison of the antimicrobial activities

Test organisms		Diameter of inhibition zone in mm.	
		Antibiotic from *A. chevalieri*	Gliotoxin
Bacteria			
Bacillus subtilis	..	28	20
B. anthracis	..	25	30
B. cereus	..	–	32
Staphylococcus albus	..	–	24
S. fæcalis	..	–	28
S. aureus	..	–	34
Salmonella typhosa	..	38	25
Aerobacter aerogenes	.	–	24
Escherichia coli	..	24	26
Proteus vulgaris	..	–	25
Vibrio choleræ	.	–	28
Pseudomonas æruginosa	..	–	18
Fungi			
Aspergillus niger	..	–	34
Alternaria solani	..	–	15
Penicillium notatum	..	–	38
P chrysogenum	..	–	30
Trichoderma viridæ	..	–	24
Saccharomyces cerevisea	..	–	18
Candida albicans	..	–	18

"–" absence of inhibition.

The results as presented in Table I show wide differences in the antimicrobial spectrum of the two antibiotics. The antibiotic isolated in our laboratory could be distinguished from gliotoxin as it was only antibacterial whereas the latter was both antifungal and antibacterial.

Our sincere thanks are due to Dr. Khanchandani, Stevens Institute of Technology, New Jersey, for the sample of gliotoxin.

Dept. of Microbiology, G. NANDA.
Bose Institute, A. PAL.
Calcutta-9, *July* 22, 1969. P. NANDI.

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BACTERIAL BLIGHT OF *LEEA EDGEWORTHII* INCITED BY *XANTHOMONAS LEEANUM*, SP. NOV.

Leea edgeworthii Sant. (= *L. aspera* Adgew.) of the family of Vitaceæ grows in forest area during rainy season. A bacterial disease was noticed on this plant at Wagai, Dangs (Gujarat), during August-December 1967–68. The disease is easy to recognise, since by sectioning the infected portions, the bacterial ooze from the vascular strands becomes quite conspicuous.

The disease first appears at the leaf margin, then spreads over a considerable area and develops as a blight. Young leaves are entirely blighted, while the mature leaves are only marginally blighted. The infected portion in the beginning turns yellow, later becomes reddish-brown in colour and finally disintegrates. The pathogen seems to enter through hydathods.

The pathogen was isolated on PDA medium by streaking and dilution-poured plate technique. On inoculation, both young and mature plants of *L. edgeworthii* developed the typical symptoms in about 15 days. The pathogen, on reisolation from the inoculated leaves, was found to be identical with one originally isolated from infected leaves.

On artificial inoculation, the pathogen could not infect *Vitis carnosa* W., *V. trifolia* L., *V. vinifera* L., *Aegle marmelos* C., *Cajanus cajan* M., *Capsicum annuum* L., *Carissa carandas* L., *Cyamopsis tetragonoloba* T., *Lawsonia alba* L., *Gossypium arboreum* L., *Phaseolus vulgaris* L., *Ricinus communis* L., *Sorghum vulgare* P., *Triticum vulgare* H., *Vernonia cinerea* L., *Vigna catjang* W. and *Citrus* sp.

The morphological, cultural and physiological characteristics of the pathogen, inciting the disease, place it in the genus *Xanthomonas*. There is no *Xanthomonas* disease so far reported for the host *L. edgeworthii*. The pathogen under study differs in certain biochemical reactions and host-range, from *Xanthomonas vitis-carnosæ* Moniz and Patel[1] and *X. vitis-trifoliæ* Padhya, Patel and Kotasthane,[2] the pathogen reported for other plants of the Vitaceæ family. It is, therefore, proposed to assign a new name *Xanthomonas leeanum* nov. sp. to this pathogen. The technical description of the pathogen is as follows :

Xanthomonas leeanum Patel and Kotasthane. —Short rods with rounded ends, usually singly, rarely in pair, measuring 1·2–1·8 × 0·5–0·7 microns, gram-negative, motile with polar single flagellum, encapsulated, no endospore, non-acid-fast. Colonies on PDA plates are big, circular with smooth surface, entire margin, raised, opaque, mucoid, butyrous and glistening yellow. Growth on PDA slant is abundant, filiform, raised, opaque, mucoid, butyrous and glistening yellow. Growth on Nutrient agar slant is same but moderate.

Starch hydrolysed, casein digested, tributyrin hydrolysed, gelatin liquefied and hydrolysed, milk peptonised and litmus reduced, nitrates not reduced to nitrites, indole not produced, H_2S and NH_3 gas produced, V.P. and M.R. tests negative, citrate utilised, uric acid not utilised, urease negative, catalase positive, tolerates 3% NaCl but not 5%. Acid without gas from glucose, lactose, maltose, sucrose, arabinose, fructose, mannose, sorbitol, inulin, cellobiose, glycogen and galactose but no acid and no gas from mannitol, xylose, raffinose, rhamnose, salicin, inocitol, dulcitol, glycerol, esculin and sorbose. Optimum temperature for growth is 28–30° C, thermal death point is 53° C, aerobe.

Pathogenic only to *Leea edgeworthii* producing blighting symptoms on leaves.

Thanks are due to Dr. M. V. Desai, College of Agriculture, Anand, for his kind help.

Microbiology Department, A. M. Patel.
B.P. Baria Science Inst., W. V. Kotasthane.
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CHEMICALLY INDUCED MUTATIONS IN COWPEA (*VIGNA SINENSIS* L., SAVI)

Cowpea ($2n = 22$), although an important pulse, vegetable and fodder crop, has not been subjected to systematic mutation studies. Only a few induced mutations have been described by Tavcar[1] and Jones,[2] and its radiosensitivity to gamma-rays was studied by Constantin and Love.[3] The present investigations, however, demonstrated that cowpea is an excellent material for studying some interesting phenomena of experimental mutagenesis and gene action.

Dry seeds of variety Pusa Phalguni were treated with 10 doses each of dimethyl sulphate (DMS), ethylmethane sulphonate (EMS), and N-nitrosomethyl urea (NMU). Various combinations of concentration and exposures were used (Table I).

All the three mutagens used gave a reduction in fertility of M_1 plants, the differences among the mutagens were not marked (Table I).

Table I

Effect of DMS, EMS and NMU on M_1-fertility and mutation rate in M_2 generation

Mutagen	Concentration %	Exposure hr.	No. of seeds per pod	Plant progenies in M_2	
				Total	% mutated
Control	..	..	9·7	50	0·0
DMS	0·1 to 0·8	2 16	7·0	225	11·1
EMS	0·025 to 0·2	2–16	8·3	178	9·6
NMU	0·01 to 0·08	2–16	6·9	55	18·2

On the basis of mutation frequency in M_2 (Table I) the two sulphur-containing monofunctional chemicals, DMS and EMS, showed almost equal effectiveness (11·1 and 9·6% mutated progenies respectively). The polyfunctional NMU was about 1·5 to 2 times more effective (18·2% mutations). These results also demonstrate high mutagenecity of NMU which has earned this group of chemicals the term "Supermutagens" (Rapoport[4]).

The mutation types obtained were analogous to those of other leguminous crops like pea (Blixt[5]). One "late giant" type mutation was specially interesting, as the plants were very large, with large leaves, peduncles, fruits; thick, occasionally fasciated stem; large seeds with uniform brown or black-mottled testa; trailing habit and drastically late in maturity. In spite of such drastic changes the plants maintained high fertility and were high yielding. Such mutations constituted 11·3% of all the mutations recorded. The reports available in literature[6-13] indicate that the characters listed for this mutation are of dominant type. However, it is highly improbable that such a large number of dominant genetic changes could be induced by a single mutational event. Another possibility could be the existence of a "system" controlling several genes.

The kind gift of DMS and NMU from Dr. I. A. Rapoport, Institute of Chemical Physics, Academy of Sciences, U.S.S.R., Moscow, is gratefully acknowledged.

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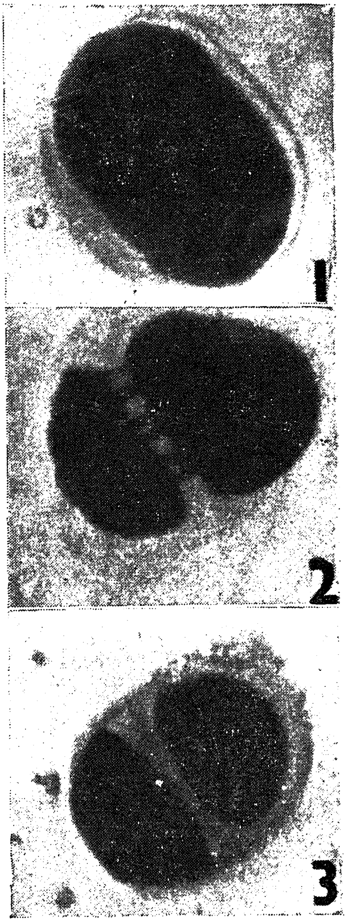
CYTOKINESIS AND MICROSPORE FORMATION IN *PLANTAGO LANCEOLATA* L.

DEPENDING upon whether cytokinesis in the microspore mother cells takes place in one or in two steps, two types have been recognized—successive and simultaneous.[1] In Plantaginaceæ the cytokinesis is of the simultaneous type,[2] except for a solitary report of successive division in *Plantago major*.[3] This note brings to record an anomaly in the mode of wall formation in a few naturally occurring plants of *Plantago lanceolata*, collected from Srinagar.

Meiosis of the microspore mother cell nucleus proceeds normally resulting in two haploid nuclei which occupy opposite poles of the cell (Fig. 1). Hereafter, development proceeds along two lines. In 137 of the 225 microspore mother cells studied, this nuclear division is followed by the vacuolation of cytoplasm along the equatorial plate of metaphase spindle (Fig. 2). Immediately afterwards furrows develop on the two sides. These invaginate till they meet in the centre and divide the cell into a dyad (Fig. 3). Nuclear division in the dyad cells is immediately followed by the development of furrows along the equatorial plates of the spindles. These, on invagination, divide the dyad into microspore tetrad of the isobilateral or tetrahedral type.

Division such as that described above is successive because it occurs in two steps. It is, however, simultaneous with regard to the mode of division. Similar type of division occurs in *Uvaria kirkii*[4] and *Annona squamosa*.[5] In order to accommodate these intermediate types, a third type of cytokinesis has been proposed which is designated as "Successive constriction"[6] or Modified simultaneous".[7]



FIGS. 1-3. Fig. 1. A microspore mother cell at Telophase I. × 600. Fig. 2. A microspore mother cell vacuolated along the metaphase spindle, × 600. Fig. 3. A dyad, × 600.

In 39% microspore mother cells cytoplasmic division is of the simultaneous type and takes place through the development of centripetally advancing furrows at the end of both the nuclear divisions. The microspore mother cells therefore develop into tetrads in just one step.

The present observation is interesting in two ways. First, majority of the microspore mother cells exhibit a modified simultaneous type of division not reported for any member of the family so far. Secondly, microspore mother cells of the same anther display a variation in the method of division.

Post-Graduate Dept. of Botany, A. K. KOUL.
Jammu and Kashmir Univ., P. K. DURANI.
Srinagar, Kashmir, *July* 14, 1969.

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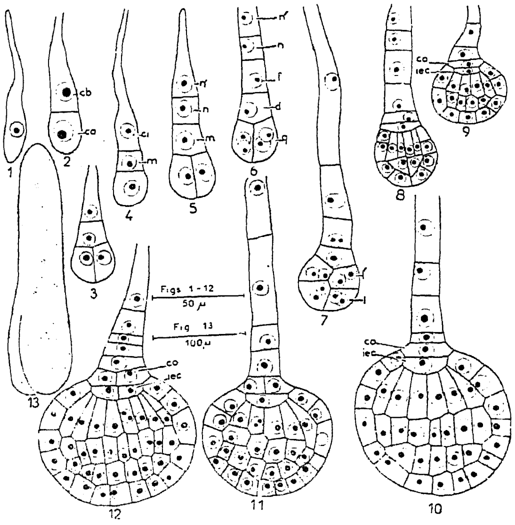
EMBRYOGENY IN *NEMESIA STRUMOSA* BENTH.

SINGH AND TANEJA[1] investigated various aspects of embryology in *Nemesia strumosa* but they did not describe the embryogeny in this plant. The present communication, therefore, deals with this aspect.

The zygote elongates considerably (Fig. 1) and undergoes a transverse division resulting in two cells, *ca* and *cb* (Fig. 2). The cell *cb* divides transversely forming two cells, *ci* and *m* (Figs. 3, 4) while the cell *ca* undergoes a vertical division (Figs. 3, 5). Another vertical division at right angles to the first results in a quadrant (Fig. 6). The cells *ci* and *m* undergo transverse division resulting in cells *n*, *n'*, *d* and *f* (Figs. 5, 6). A transverse wall is laid down in each cell of the quadrant forming two tiers, *l* and *l'*, each having four cells (Fig. 7). The suspensor formed by the cells *f*, *n* and *n'* and their derivatives becomes very long in later stages of the embryogeny. A single-layered dermatogen is separated owing to periclinal divisions in the cells of the octant (Fig. 8). After the formation of the dermatogen the divisions in the inner cells of the tier *l* and *l'* lead to the fomation of a large globular proembryo (Figs. 9-12). The cell *d* functions as the hypophysis. It first divides transversely to form two cells (Fig. 9) each of which divides further to produce two groups of cells, *iec* and *co* (Figs. 10-12). The former forms the initials of root cortex and the latter of the root cap. The cotyledonary primordia arise laterally at the apical region of the globular proembryo. The embryogeny in this plant thus conforms to the Onagrad type. The mature embryo is white, fleshy and more or less straight. The radicle is longer than the cotyledons (Fig. 13).



FIGS. 1–13

I am grateful to Dr. R. P. Singh for guidance and to Dr. L. B. Singh, Director, for facilities.

National Botanic Gardens, SAROJ TANEJA.
Lucknow, *June* 23, 1969.

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COMPARATIVE EFFECTS OF GIBBERELLIN, GROWTH RETARDANTS AND MORPHACTINS ON EXPANSION OF COTYLEDONS OF *IPOMEA PENTAPHYLLA**

RECENTLY, we observed that morphactins[1] (derivatives of fluorene-9-carboxylic acid), which show an apparent similarity of action to growth retardants in their overall growth-retarding property, somewhat increased the expansion of cotyledons.[2] It is also known that gibberellin and growth retardants have varied effects on leaf expansion.[3-6] Since physiologically, cotyledons are known to be different from 'true leaves',[7] and partly since the factors governing expansion of *Ipomea* cotyledons are as yet undefined, the following experiments were designed to evaluate the role of GA, growth retardants and morphactins, alone and in combination, on cotyledon expansion. These results are presented in this report.

Seeds of *I. pentaphylla* were germinated in 10 cm. petri dishes in light for 40 hr. and the cotyledons excised from these seedlings were used for the experiments. Six cotyledons were floated in each petri dish lined with a single layer of filter-paper moistened with 5 ml. of distilled water or the test solution. The experiments were carried out at 25° C. and during the experimental period the cotyledons received a light intensity of about 1,000 lux for 16 hr. a day. The results relating to expansion of cotyledons in solutions of various growth regulators for 48 hr. are shown in Tables I and II.

TABLE I

Expansion of isolated Ipomea *cotyledons in different growth retardants*

Chemical	Concentration in p.p.m. 100	1,000	2,000
	Area of cotyledons in sq. mm. ± S.D.		
CCC	332 ± 42	318 ± 42	305 ± 40
Phosfon	272 ± 34	..	..
B-nine	342 ± 40	307 ± 38	287 ± 36

Area of cotyledons in control: 344 ± 38 sq. mm.

TABLE II

Effect of morphactin and gibberellin, alone and in combination with growth retardants, on cotyledon expansion

Chemical (conc. in p p m.)	Area of cotyledons (sq. mm. ± S D)	% Control
Control	344 ± 38	..
GA_1	470 ± 30	+36·6
GA_{10}	350 ± 32	+54·0
M_{50}	370 ± 38	+77·5
$M_{50}+GA_1$	334 ± 30	− 2·9
$M_{50}+GA_{10}$	314 ± 32	− 8·7
$CCC_{1000}+GA_{10}$	485 ± 34	+40·9
$Phosfon_{100}+GA_{10}$	282 ± 30	−18·0
$B\text{-}nine_{1000}+GA_{10}$	475 ± 32	+38·0

It is clear from the results that all the growth retardants tested inhibited somewhat the expansion of cotyledons; the most marked inhibition of cotyledons was observed in those reared in petri dishes containing phosfon. Phosfon, besides affecting expansion of cotyledons also inhibited formation of chlorophyll in the cotyledons and they remained pale yellow in colour. Concentrations higher than 100 p.p.m. were not used since toxic symptoms became apparent. Although at a concentration of 2,000 p.p.m. even CCC inhibited formation of chlorophyll in cotyledons, this inhibition was found to be less pronounced in comparison to that observed in phosfon-treated cotyledons. Thus in conclusion it is apparent that, as in the leaves of the treated plants, the growth retardants also inhibit expansion of *Ipomea* cotyledons.

Results relating to the effect of GA, morphactin and interaction of GA with growth retardants have been presented in Table II. It is clear that GA caused marked expansion of the cotyledons. Besides, when used in combination with CCC or B-nine, GA also successfully reversed the inhibition of expansion caused by the former substances. However, in the presence of phosfon, even GA remained ineffective in exerting its influence on cotyledon expansion. It might be quite possible that, at least in this case, the effects of GA and phosfon are not mediated through common site of action as seems to be the case of CCC and GA, or B-nine and GA.

Further, it was interesting to note that, as far as expansion of *Ipomea* cotyledons was concerned, although both GA and morphactin, when alone stimulated cotyledon expansion, in combination they acted antagonistically to each other and greatly inhibited expansion. Recently, similar antagonism between morphactin and GA has been reported in the case of growth of vine tissue cultures.[8]

Grateful thanks are due to Dr. Schraudolf (Giesen) for the gift of B-nine; Merck AG for morphactin; M/S BASF (Germany) for CCC; Mobil and Co. for phosfon, and to Prof. Egle (FFM/Germany) in whose laboratory this work was initiated.

Botany Department, NARENDRA SANKHLA.
The University,
Jodhpur, *June* 25, 1969.

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* Abbreviations used: CCC, (2-chloroethyl)-trimethyl ammonium chloride; B-nine, N, N-dimethyl amino-succinamic acid; M, morphactin (butyl ester); GA, gibbberellic acid.

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NIACIN INHIBITION OF GERMINATION AND EARLY GROWTH OF CERTAIN COMMON CEREALS OF RAJASTHAN (INDIA)

NIACIN requirement has been reported during seed germination and early growth of many orchids in the absence of a proper fungal associate.[1] Stimulation of germination and growth of isolated embryos by nicotinamide treatment has been reported for oats.[2,3] There appears to be no reference in the literature

TABLE I

Inhibition of the seed germination as affected by various concentrations of niacin

Seeds	Percentage of germination in 72 hours						
	Concentration of the chemical in p.p.m.						
	50	100	250	500	1,000	1 500	Control
P. typhoides var. Hybrid	32±3	25±4	19±3	5±2	0	0	92±5
P. typhoides var. R S K	35±5	17±5	12±3	8±1	0	0	97±3
S. vulgare var. Hybrid	72±7	68±4	52±2	46±4	26±3	0	98±4

relating to the germination inhibition action of niacin on the germination phase of most of the commonly cultivated crop plants of Rajasthan.

This report deals with the inhibitory effect of niacin (nicotinic acid) on germination and early growth of the seedlings of the two most important cereals of Rajasthan, *i.e., Pennisetum typhoides* var. Hybrid and *Pennisetum typhoides* var. R S K and *Sorghum vulgare* var. Hybrid. The pure line seeds, obtained from Agriculture Department of the Rajasthan Government at Jodhpur, were used for this study. Niacin was obtained from B.D.H. (India). An aqueous solution of 2,000 p.p.m. was prepared and was used as a stock solution.

The seeds were soaked with 50, 100, 250, 500, 1,000 and 1,500 p.p.m. of niacin for 12–16 hours. The pre-soaked seeds were thoroughly washed with distilled water and were germinated in sterilised petri dishes containing filter-paper (Whatman No. 1) and double distilled water. Germination experiments were conducted under artificial light (tube lights) at a temperature of 30° C. ± 2° C. A control set, in which seeds were pre-soaked in double distilled water, was run along with each set of experiments for a total period of 72 hours. There were three replications for each set of experiments.

The higher concentrations of the chemical, *viz.,* 1,000 and 1,500 p.p.m. brought about complete inhibition in germination of the cereals named above. Germination percentage in the control sets was very high, being 90 to 95% in all the sets. The inhibitory effect of the chemical, as observed on the seeds of the two plants, was more marked in case of *P. typhoides* than in *S. vulgare*. In the case of the former, in nearly 90% of the seeds, when pre-soaked in a solution of 500 p.p.m. niacin, a high degree of inhibition of germination was noticed. But seeds soaked with 50, 100 and 250 p.p.m. of the chemical indicated increase in germination percentage inversely with the concentrations used. The probable relationship between the concentration of the chemical used and its inhibitory effect on germination of these seeds might be stated thus: the higher the concentration of the chemical, the lower was the rate of germination (Table I).

All seeds, pre-soaked with 500, 250 and 100 p.p.m. of the chemical, exhibited a difference in their seedling growth as indicated by the length of seedlings at the end of the experimental period, *viz.,* 72 hours, the growth of the control sets being always higher than that of the experimental sets. A marked contrast was apparent between the lengths of seedlings in the control sets and those obtained from seeds treated with 500 and 250 p.p.m. of the chemical (Table II). It might be deduced that retardation of the growth of the seedlings increases with increasingly greater concentration of niacin.

TABLE II

Effect of different concentration of niacin on the seedling growth

Plant species	Mean length of the seedlings in cm.				
	Concentration of the chemical in p.p.m.				
	50	100	250	500	Control
P. typhoides var. Hybrid	6·2	4·0	2·0	1·0	7·8
P. tykhoides var. R S K	5·5	3·8	2·5	1·6	7·5
S. vulgare var. Hybrid	2·2	2·5	2·3	1·7	3·9

1. Variation in the growth was ±0·3 cm.
2. The results indicate final length of the seedlings at the end of 72 hours.

The present work is only a preliminary investigation and it would not be safe to venture any definite conclusion from the data obtained. It might, however, be presumed that the inhibitory effect of the chemical might possibly be due to its interference with certain metabolic pathways.

Department of Botany,
University of Jodhpur,
Jodhpur, *July* 28, 1969.

PRAKASH MULLICK.
U. N. CHATTERJI.

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REVIEWS AND NOTICES OF BOOKS

Animal Mechanics. By R. McNeill Alexander. (University of Washington Press, Seattle), 1968. Pp. x + 346. Price $9.50.

This book is about the parts of mechanics that have been useful in zoology, and about some of the zoological investigations in which they have been used. Since this volume is designed primarily for zoologists and their students, who may not possess an extensive background in engineering, mathematical proofs of the formulas included in the text are omitted. References are provided to indicate where such proofs may be found.

Each chapter deals with a major branch of mechanics. Each consists of alternating sections on mechanics and zoology: a section on a mechanical topic is followed by one or more sections on zoological topics involving the mechanical one, before the next mechanical topic is introduced. This means that related zoological topics involving different branches of mechanics may be widely separated. In such cases, the author has put cross-references in the text.

Chapter 1, "Force and Energy", dealing with the application of statics and dynamics to zoology, discusses mechanical advantage; work and efficiency of muscular effort, as in a locust's jump; and similar examples.

Chapter 2, "Joints and Mechanics", introduces important kinematic principles and illustrates these by reference to mammal and arthropod joints, kinematic skulls, fish spines, and other appropriate features.

Chapter 3, "Elasticity and Viscosity", focuses on animal structural materials and their similarities to high polymers.

Chapter 4, "Strength", draws upon a variety of anatomical examples to illuminate simple and complex patterns of stresses and strains in tissues and organ systems.

Chapter 5, "Pressure, Density and Surface Tension", is devoted to an examination of all branches of hydrostatics with emphasis upon the interaction between animals and their liquid environment.

Chapter 6, "Motion in Fluids", is concerned with the interactions when a fluid or gas moves within and around solids. Emphasis is placed on both aerial and aquatic animals.

Chapter 7, "Vibrations and Changing Forces", a study of sound, deals with spiders' webs, the flight muscles of insects, hearing in fish, echo-location in bats, swim-bladders, and related topics.

The text is fully illustrated with more than 130 line drawings. C. V. R.

Selected Papers on Desalination and Ocean Technology. Edited by Sumner N. Levine. (Dover Publications, Inc., New York), 1968. Pp. x + 437. Price $4.00.

In this book, two dozen recent (1956-65) papers, collected from journals, symposia, government publications, and other sources, are published together for the first time. Written by engineers, researchers, chemists and other experts, these papers discuss the processes of desalination, the economics of the techniques, and secondary uses for desalination plants.

Each paper is reprinted complete with bibliographic references, illustrations, and diagrams, making this book a reference and study volume for design engineers, for researchers, for chemists, and for other specialists concerned about recent developments and potential growth in the field of desalination.

Contents: Survey of Desalination, Summer N. Levine; 18 papers on general techniques and economics of desalination, including five papers on by-products of saline water conversion, a critical review of the literature on scaling problems, studies of practical experiences in Kuwait and San Diego, reports on dual-purpose plants, etc.; four papers on the design, equipment and economics of the electrodialytic process plant; and two papers on more experimental techniques—reverse osmosis and the freezing process.

First book publication. 24 papers complete. Introductory Survey by the editor. Bibliographies. 86 tables, 171 diagrams, maps, charts. 43 photographs. C. V. R.

Remote Sensing of Environment—*An Interdisciplinary Journal* (Vol. I, No. 1). (American Elsevier Publishing Company, Inc., New York), 1969. Pp. vii + 80.

This journal was established in recognition of the existence of the new, many-faceted, interdisciplinary research area involving the use of remote sensors.

The growing areas of many sciences are those in contact with other disciplines. In the remote sensing context, ideas and techniques developed in one discipline may be transferable with only modest changes to another. *Remote Sensing of Environment* provides a forum for this type of exchange to complement Remote Sensing Symposia held at the University of Michigan and other universities and at special sessions of professional societies.

Volume 1 contains the following papers: Integrated Landscape Analysis with Radar Imagery; Investigation of Clouds above Snow Surfaces Utilizing Radiation Measurements Obtained from the Nimbus II Satellite; Equipment and Techniques for Low-Altitude Aerial Sensing of Water-Vapor Concentration and Movement; Reflectance of Cotton Leaves and Their Structure; Making Color Infrared Film a More Effective High-Altitude Remote Sensor; Some Observations on the Use of Multiband Spectral Reconnaissance for the Inventory of Wildland Resources; Applications on an Airborne Pulsed Laser for Nearshore Bathymetric Measurements; Radar Altimetry from a Spacecraft and its Potential Applications to Geodesy and Oceanographic Applications of Radar Altimetry from a Spacecraft. C. V. R.

Elementary Solid State Physics (Part I). By R. Ramaswamy. (Published by Mrs. Lakshmi Ramaswamy, C-37, Tirunagar, Madurai-6), Pp. 165. Price Rs. 6.00.

This is a carefully prepared book by a teacher of experience to introduce the essentials of solid state physics to beginning students of science and engineering. The material is presented in five chapters, namely, Solid State of Matter; Solid Structures; Thermal Properties of Matter; Magnetic Properties of Matter; and Electrical Conduction in Metals. The book is clearly written and easy to follow.

A. S. G.

Physics Experiments and Projects : Vol. 5—*Mechanics*. By W. Bolton. (Pergamon Press, Ltd., Headington Hill Hall, Oxford), 1969. Pp. 121. Price: Hard Cover 18 *sh*; Flexicover (net) 9 *sh*.

The earlier volumes in this series were reviewed in these columns (see *Curr. Sci.*, 1968, 37, 540). Designed on the same lines as the other volumes, the fifth in the series is devoted to Mechanics, and sets forth 67 simple experiments and 15 projects. A useful series for self-learning and class teaching. A. S. G.

ANNOUNCEMENTS

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Chemistry to Shri D. Subba Rao.

Calcutta University has awarded the D.Sc. degree in Physiology to Sri Bhupendranath Chaudhuri.

Karnatak University has awarded the Ph.D degree in Statistics to Shri M. S. Chikkagoudar Ph.D. degree in Botany to Shri S. G. Bharati

M.S. University of Baroda has awarded th Ph.D. degree in Statistics to Shri Avadhoo Gangadhar Phatak; Ph.D. degree in Geolog to Shri Subhash Jagdishkumar Desai; Ph.D degree in Chemistry to Shri Ramesh Subbayy Hegde.

Osmania University has awarded the Ph.D degree in Chemistry to Shri K. S. Sudarshan Rao; Ph.D. degree in Geology to Shri Sye Khalid Razvi.

Symposium in Estuarine Biology

The First All-India Symposium in Estuarin Biology will be held in the Department c Zoology, Madras Christian College, Tambaram Madras-59, from the 27th till the 30th Decembe 1969. Prof. R. V. Seshaiya will be the Presider of this Symposium and Dr. N. K. Panikkar wi deliver the inaugural address. There will b a field-trip to Pulicat Lake and the Estuarin Biological Laboratory of this college.

Intending participants may contact th Convener, Prof. P. J. Sanjeeva Raj at th above address, for further particulars.

Symposium on Earthquake Engineering

The Fourth Symposium on Earthquak Engineering will be held at Roorkee on 14, 1 and 16 November 1970.

For further information please write t School of Research and Training in Earthquak Engineering, University of Roorkee, Roorkee U.P., India.

Books Received

Lectures on Ordinary Differential Equations By Einar Hille. (Addison-Wesley Publishin Co., Inc., London W. 1), 1969. Pp. xi + 723 Price 163 *sh*.

Introduction to Commutation Algebra. By M. F. Atiyah and I. G. Macdonald. (Addison-Wesley Publishing Co., Inc., London W. 1), 1969. Pp. ix + 128. Price 70 *sh*.

1486-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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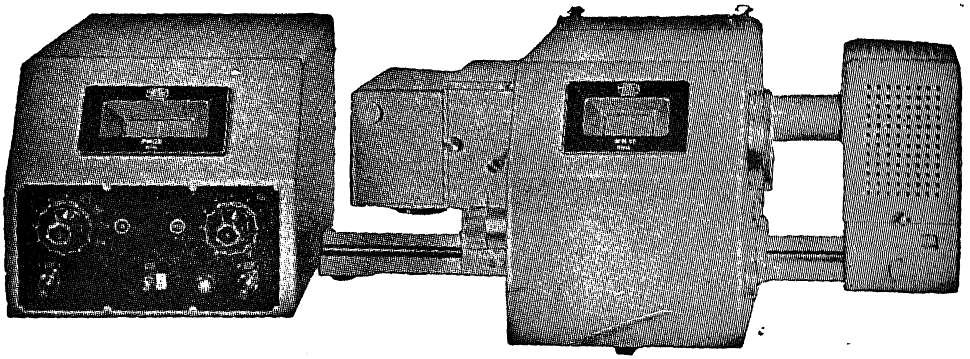

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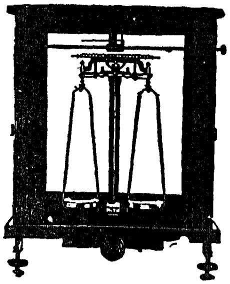

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SPECTROPHOTOMETRY OF FLORAL EXTRACTS

SIR C. V. RAMAN

ABSTRACT

Spectrophotometer records of the absorption spectra of the acetone extracts of the pigments of four flowers, respectively red, purple, blue and yellow in colour, are reproduced, with appropriate comments on the features which they exhibit.

1. INTRODUCTION

MANY flowers which present attractive colours exhibit an intense absorption over extensive regions in the spectrum. It is not easy in such cases to determine by simple observations *in vivo* the nature of the pigmentary materials responsible for the observed colours. The extraction of the pigment from the petals by appropriate solvents, *e.g.*, acetone, followed by spectrophotometric examination of the extract diluted to such extent as may be found necessary is very helpful in such cases. Likewise, a similar procedure may be followed with advantage in the case of flowers exhibiting very delicate colours, the spectral character of which is not easily acceptable to direct observation. Extended studies of this kind with many flowers should be of help for a fuller understanding of the origins of floral colour in general. The present communication reports the results obtained in a few typical cases of this nature.

2. *Hibiscus rosa sinensis*

This is a widespreading shrub, 5–8 feet high with bright shining thick foliage. It is constantly in bloom with large brilliant scarlet-red flowers which have pretty columns of pistil and stamens projecting from their centres. The shrub with its flowers has an attractive appearance as seen from a distance and hence is very effective as an ornamental hedge. Viewed through a direct-vision spectroscope, the flowers exhibit wavelengths greater than 600 mμ in full strength, while shorter wavelengths suffer a practically complete extinction. Immersion of the petals in acetone results in a rapid extraction of the colour. Viewed through a spectroscope, a 5 cm. column of the extract exhibits visible absorption bands in the yellow and green sectors followed by a strong general absorption in the blue region. Figure 1 is a spectrophotometer record obtained with an absorption cell 2 cm. thick. The numbers entered in the figure are the wavelengths in angstrom units. It will be seen that apart from the three absorption bands in the yellow, green and blue-green characteristic of Florachrome B, two other bands are noticeable in the blue and violet regions of the spectrum. It may be inferred from this that besides Florachrome B which is responsible for the red colour, there is also present a yellow pigment which has a strong absorption in the short-wave region of the spectrum. This inference receives support from the fact that the colour of the acetone extract does not fade away completely after 24 hours as in the case of the extracts from red or crimson roses but exhibits a residual yellow. It should, no doubt, be possible to separate the red and yellow pigments by chromatographic methods.

3. *Lagerstroemia indica purpurea*

This shrub belongs to the botanical class *Lythraceæ* and is popularly known as a crape myrtle. It is a deciduous shrub 6–10 feet high with small leaves and is very pretty in bloom with soft, fringed, showy flowers arranged in long erect sprays. The colour is readily extracted from the material by immersion in acetone. The spectrophotometric record of absorption by a centimetre column of the acetone extract is reproduced as Fig. 2.

The record shows some similarity to that of the acetone extract from the reddish-purple ground-orchid. *Spathoglottis plicta,* which *in vivo*, exhibits the typical spectrum of Florachrome B with absorption bands appearing conspicuously in the yellow, green and green-blue regions of the spectrum.

4. *Jacquemontia violacea*

This belongs to the botanical order *Convolvulaceæ,* and is a small very free-blooming creeper with small cordate leaves. The flowers are also small and bell-shaped. They are blue in colour and are borne plentifully in all seasons. Hence, the creeper is sometimes referred to as *Ipomea semperflorens.* The colour may be extracted by grinding a sufficient number of the petals with acetone in an agate mortar.

Examined *in vivo,* the flower shows quite conspicuously the absorption bands in the yellow and in the orange-red regions in the

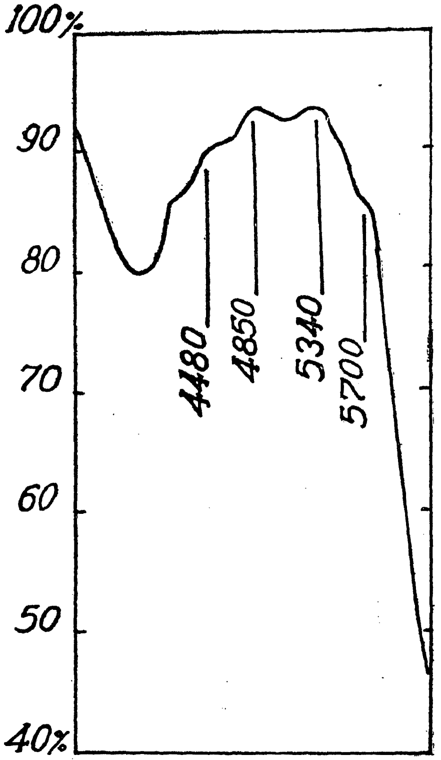


FIG. 1. Absorption spectrum of the red *Hibiscus.*

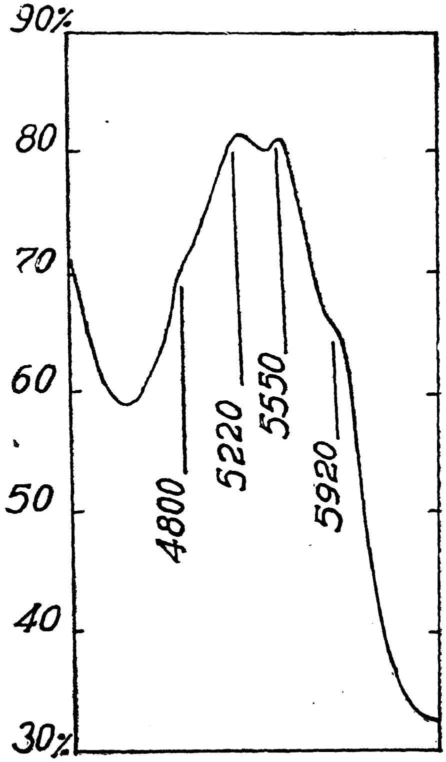


FIG. 2. Absorption spectrum of the purple *Lagerstroemia.*

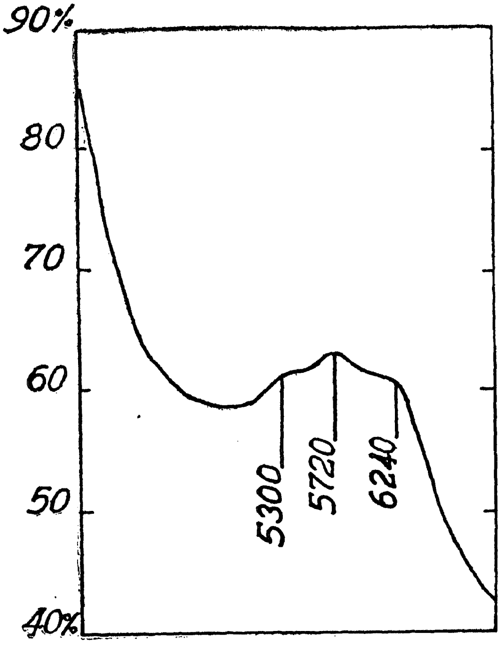


FIG. 3. Absorption spectrum of the blue *Jacquemontia.*

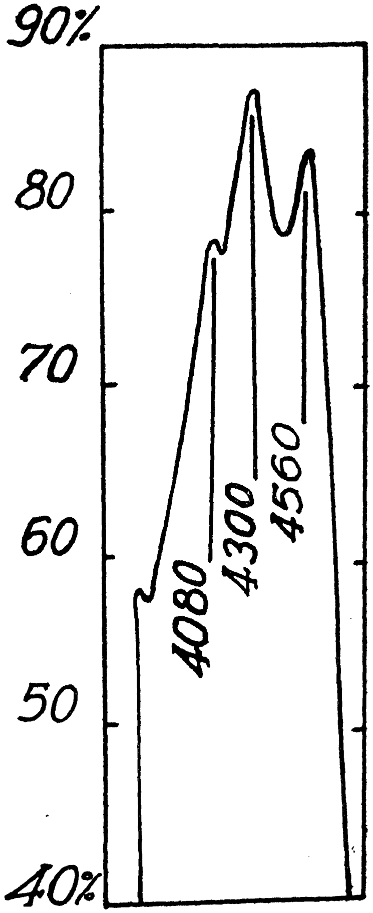


FIG. 4. sorption spectrum of the yellow *Tecoma.*

spectrum which are responsible for the blue colour which it exhibits. A five-centimetre column of the acetone extract exhibits a purplish-blue colour which is spectroscopically revealed as due to a conspicuous absorption-band covering the yellow region of the spectrum, a less conspicuous diffuse band in the red and a general weakening of the green region of the spectrum. The blue region in the spectrum is transmitted with fair strength. These features are recognisable in the spectrophotometer record of the absorption by a centimetre column of the acetone extract reproduced as Fig. 3. The spectral behaviour of the flower thus definitely belongs to the class Florachrome A.

5. *Tecoma stans*

This is a large shrub belonging to the botanical class *Bignoniaceæ*. It is a very hardy quick grower attaining a height of about 10 feet. The foliage is handsome, consisting of graceful pinnate leaves. The shrub is commonly planted for screening compound walls or as hedging. The flowers are golden-yellow in colour, large, funnel-shaped and widely expanded and appear as clusters in terminal branches. The colour is readily extracted from them by immersion in acetone. Examined *in vivo*, the flowers exhibit a practically complete extinction of the shorter wavelengths in the spectrum upto about $510\,m\mu$, while the rest of the spectrum appears in full strength. The acetone extract exhibits the same spectroscopic behaviour. Figure 4 reproduces a spectrophotometer record of the diluted extract. It shows three bands in the blue-violet region of the spectrum, indicating that the pigment may be identified as a carotenoid.

The records reproduced above were made in the Instruments Section of the Indian Institute of Science, to the authorities of which institution, the thanks of the author are due.

MICROSCOPIC SCREENING OF RICE GRAINS FOR PROTEIN CHARACTERISTICS

A. K. KAUL, MISS R. D. DHAR AND M. S. SWAMINATHAN
Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi-12

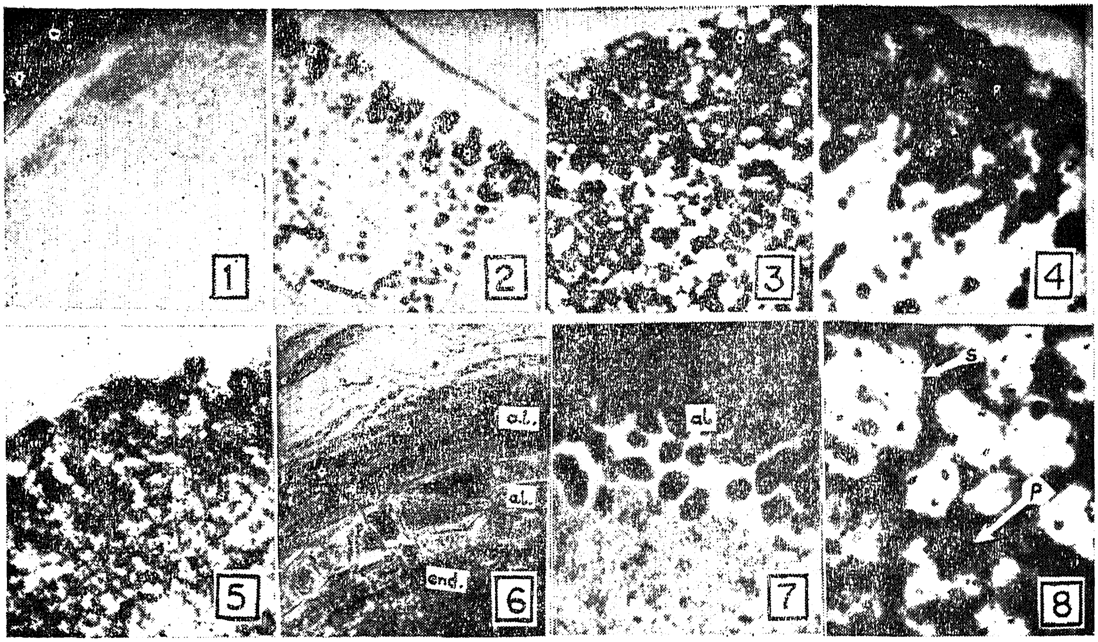
A MICRO-DYE-BINDING capacity (DBC) technique was earlier described for analyzing proteins in single grains of rice.[1] Since rice is mostly consumed in the milled or polished form, and since polishing results in varying extent of losses of the outer layers of endosperm, a study of proteins of the caryopsis *in situ* would be of interest. Several histological and ultrastructure studies have been conducted in the rice grain to obtain morphological and biochemical information on the developing grain.[2–7] In our programme aiming at the development of rice strains with superior quantity, quality and distribution of proteins, a rapid test that would enable the screening of thousands of strains of wild and cultivated rices as well as segregating material from crosses between diverse strains and varieties obtained in induced mutation programmes became necessary. For this purpose, a system of microscopic screening of transverse sections of the grain was developed. This technique is discussed in this paper in relation to the D.B.C. method for single grains, reported earlier.

Rice grains, of uniform maturity, were fixed in Cornoys fixative for 48 hours and stored in 70% alcohol. Protein specific dyes such as Orange G, Bromophenol blue, Sakaguchi's reagent, Alloxan, Xylidine-ponceau, Ninhydrin, Amido black and Nigrosine were used. Among these Bromophenol blue was found useful for routine studies because of both ease of preparation and satisfactory resolution. The hand sections were cut with a 'Weck' blade and stained for two minutes in 1% aqueous Bromophenol blue solution; dehydrated with ascending grades of alcohol/water, clove oil and xylene and finally mounted in Euperol. One technician was able to screen 15–20 strains in 7 hours.

The proteins of rice grain occur in the form of (*a*) well-formed irregular bodies, $3\text{-}20\,\mu$ in size, surrounded by amyloplasts (Fig. 8)[2,8] and (*b*) a membranous network composed of very small dots (Fig. 2).[2,4] These structural differences are genotypically determined.[9] A variety might exhibit either of the two types of configuration or both with varying intensities (Figs. 3 and 5). In the material studied by us, the following four major types of protein distribution were recognised:

Type 1. Peripheral and diffused network.

Type 2. Single layer of well-formed bodies.



FIGS. 1–8. Transverse sections of various rice strains. Fig. 1. Protein pattern: 1·0 type. (Peripheral diffused.) Fig. 2. Protein pattern 2·1. Dense peripheral protein bodies and dispersed membranous characterization (arrow). Fig. 3. Protein pattern 3·2. Deep-seated membranous proteins with few disrupted bodies on periphery. Fig. 4. Protein pattern 4·0. Deep distributed dense protein bodies. Fig. 5. 4·3 pattern. The idealmost characterization having body proteins and dispersed proteins with equal intensities. Fig. 6. A magnified view of the outer tissues of a mature rice caryopsis. Two layers of aleurone (*al.*) and several compressed layers of outer tissues (*o.l.*) are seen. Fig. 7. A strain of rice showing five layers of aleurone (*al.*) zone. Fig. 8. Protein bodies (*P*) interspaced between the compound starch amyloplasts (*S*).

Type 3. Deep diffused network.

Type 4. Deep multilayered protein bodies.

It was observed that some genotypes have mixed profiles (Figs. 3 and 5), *e.g.*, type 2·3 would have a single layer of well-formed bodies with a network of diffused proteins in the inner layers and Type 4·3 will have many layers of dense protein bodies intermixed with a deep diffused network.

The authenticity of these microscopic observations, and thereby the practicability of using the above-mentioned scale, was confirmed with the single grain D.B.C. technique. A remarkably high correlation coefficient (+ 0·906**) was obtained between the score readings and the D.B.C. absorption values (Fig. 9). Thus, the visual scoring of protein can be successfully quantified.

Among the cereal proteins, rice protein has the most desirable aminogram.[9,10] When comparisons of the amino-acid content expressed as percentage of protein of brown rice, milled rice, germ, polishing and bran are made, it is found that the bran and germ aminograms are better than those of brown and polished rice.

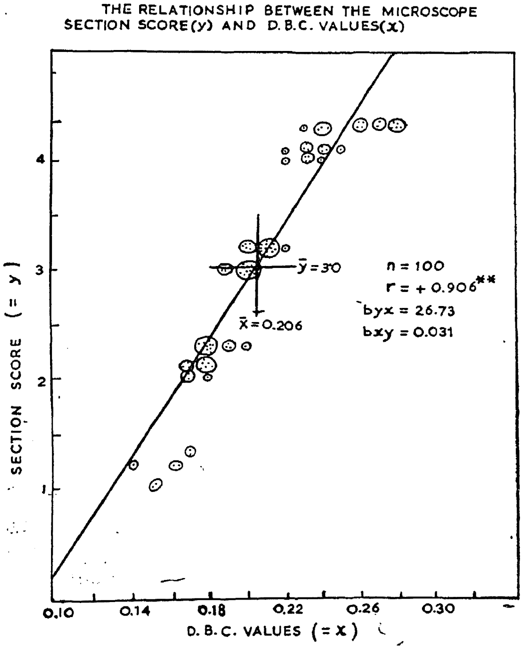


FIG. 9

This qualitative difference is more marked in the case of lysine, threonine and tryptophan.[11,12] This observation suggests that milling results in not only quantitative but qualitative losses as well. Hence, deep-seated and diffused protein bodies belonging to the type 4·3 pattern would be desirable for retaining the nutritive value of milled rice. The rapid technique described in this paper would be of use in screening world collections and mutagen-treated populations for this trait.

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ENHANCED VIRAL HAEMAGGLUTINATION WITH TRYPSINISED ERYTHROCYTES

U. C. CHATURVEDI, (MISS) ASHA MATHUR, O. P. BHARADWAJ,
L. M. BAHUGUNA AND R. M. L. MEHROTRA

From the Upgraded Department of Pathology and Bacteriology, K.G. Medical College, Lucknow, India

MORTON AND PICKLES[1] observed that treatment of erythrocytes with trypsin resulted in marked increase in agglutinability of M, N, S and A, B, O and P receptors by their corresponding antisera. Trypsin treatment of erythrocytes was also found of great help in the demonstration of Rh incomplete antibodies. On the other hand, marked reduction or abolition of viral hæmagglutination with trypsin-treated erythrocytes has been reported for influenza,[2] ECHO[3] and reo type 1 and 2 viruses.[4] We are not aware of any report in literature describing enhancement of agglutinability of trypsinized red cell by any virus. The present report describes the increased hæmagglutination titres of arboviruses against trypsinized cells.

The experiments were carried out on the erythrocytes of ducks, roosters, sheep, guinea-pigs, human blood group 'O' subjects, rabbits and frogs (*Rana tigrina*). The blood was collected in Alsever's solution and stored at 4° C. for at least 24 hours to avoid non-specific agglutination and were used within 5 days of collection. The red cells were washed thrice with isotonic saline. The packed cells were then divided into two aliquots. To one aliquot 0·1% trypsin (Difco 1 : 250) was added in proportion of 1 : 5. The trypsin solution was prepared in phosphate buffered saline pH 7·2 and was Seitz-filtered for sterilization. To another portion of packed erythrocytes, phosphate buffered saline was similarly added for control. Both the test and control erythrocytes were then incubated at 37° C. for 1 hour. After incubation the cells were immediately washed thrice with isotonic saline. The erythrocytes were then suspended in 0·4% concentration in virus-adjusting diluent of pH 6·6 for KFD virus and pH 6·4 for JBE virus antigens. The two arboviruses used were Kyasanur Forest Disease (KFD) and

Japanese B. Encephalitis (JBE) viruses belonging to group B. The antigens were acetone-ether-extracted mouse brains prepared from P9605 strain of KFD and P20778 strain of JBE viruses and were obtained from the Virus Research Centre, Poona, India. The hæmagglutination tests were set up with trypsinized and untreated control erythrocytes against the above-mentioned viruses using micro-technique of Clarke and Casals.[5] With each type of cells, control tests were set using virus-adjusting diluent in place of antigen. Two drops of viral dilutions mixed with equal amounts of erythrocytes were taken in microtitre HI plates and incubated at 4° C. for 90 minutes. The highest dilution of the viral antigen giving complete agglutination was considered as the titre of the virus for that erythrocyte. The experiments were performed on 3 to 5 animals of one particular species and were repeated at least three times on erythrocytes from one animal.

TABLE I

Shows hæmagglutination titres of KFD and JBE virus antigens against untreated and trypsinized erythrocytes

Erythrocytes		Hæmagglutination titres					
		KFD virus antigen			JBE virus antigen		
		Untreated	Treated	Degree of increase	Untreated	Treated	Degree of increase
Duck	..	2,560	2,0480	8-folds	1,280	20,480	16-folds
Rooster	..	160	5,120	32-folds	1280	40,960	32-folds
Sheep	..	80	320	4-folds	80	640	8-folds
Guinea-pig	..	20	640	32-folds	40	640	16-folds
Human 'O'	..	20	40	2-folds	20	80	4-folds
Rabbit	..	20	40	„	20	40	2-folds
Frog	..	< 10	320	>32-folds	ND	ND	..

N.D. : Not done.

Table I shows the mean values of hæmagglutination titres obtained in repeated experiments with trypsinized and untreated control erythrocytes of different animals. The untreated cells of the duck were highly agglutinable giving a titre of 2,560 with KFD and 1,280 with JBE viruses. After trypsinization the titres were 20,480 with both the antigens showing an 8- and 16-fold increse respectively with KFD and JBE viruses. Rooster cells showed 160 and 1,280 titres respectively with KFD and JBE viruses which after trypsinization became 5,120 and 40,960, showing as increase of 32 folds with both the viruses. Sheep cells were weakly agglutinable and gave a titre of 80 with both the viruses but after trypsinization the titres were 320 and 640 respectively for KFD and JBE antigens, the increase being 4 and 8 folds. Guinea-pig cells were poorly agglutinable but after trypsinization the titres increased markedly being 32-fold with KFD and 16-fold with JBE viruses. Rabbit and human 'O' cells showed little alteration by trypsinization. The results with frog erythrocytes were striking. The untreated cells were found unagglutinable in the lowest dilution of 1 : 10 with KFD virus antigen. After trypsinization they were agglutinable upto 320 dilution of KFD virus antigen.

The findings of the present study thus demonstrate enhanced agglutinability of the trypsinized erythrocytes of different species of animals to KFD and JBE viruses. This is similar to (Hubener)-Thomsen-Friedenreich phenomenon, in which a pre-existing concealed receptor in the erythrocyte membrane is unmasked. The view is in accordance with Thomsen's[6] hypothesis that a latent receptor is uncovered by the influence of a catalytic agent. The conversion of unagglutinable frog erythrocytes to agglutinable by trypsin treatment is similar to the observation of Coombs *et al.*[7] who rendered unagglutinable ox erythrocytes equally agglutinable by antibodies after trypsinization. Our findings thus show that differential agglutinability of the red cells to arboviruses depends upon the presence of unmasked receptors on the cell membrane. These receptors are present on all the erythrocytes tested but the presence of unmasked receptors varies from species to species and among individuals of the same species. The findings suggest that the receptors for arboviruses are not protein in nature as they are not destroyed by trypsin treatment.

The increased agglutinability after trypsinization raises the possibility of the routine use of enzyme-treated erythrocytes as a more sensitive indicator in hæmagglutination inhibition test in diagnostic virology and would affect a 4 to 32 times economy in viral antigen depending upon the erythrocytes used.

We are thankful to Dr. T. R. Rao, Director, Virus Research Centre, Poona, for supplying the antigens.

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EFFECT OF AUXIN SYNERGISTS IN ROOTING OF FRENCH BEAN (*PHASEOLUS VULGARIS* L.) CUTTINGS

R. N. BASU*

University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, Leics, U.K.

GORTER[1] noted that indole greatly synergised the effect of IAA (3-indole acetic acid) in root production of French bean (*Phaseolus vulgaris* L.) cuttings. She quoted the results of van Raalte's[2] work on synergism in suggesting that the enhancing effect of indole on IAA-induced root formation was caused by its inhibiting effect on IAA-oxidase activity. In a later investigation Gorter[3] used indole, α- and β-naphthols and phenol in combination with IAA, NAA (α-naphthyl acetic acid) and 2, 4-D (2, 4-dichlorophenoxy acetic acid) and concluded that synergism between those chemicals and auxins did not depend on a resemblance in molecular structure of the two compounds. She assumed that the exogenously applied auxins are attacked by an unspecific oxidizing enzyme which was antagonised by chemicals like indole, α-naphthol and β-naphthol. Hess[4] used a number of mono and polyphenolic compounds in rooting of mung bean (*Phaseolus aureus* Roxb.) cuttings and stated that structural requirements for a phenolic compound to stimulate rooting were presence of at least two hydroxyl groups in an *ortho* relationship and a free *para* position in the ring.

In the present investigation the influence of a number of chemicals including indole, α- and β-naphthols and several mono and polyphenolic substances, some of which have been shown to affect the IAA-oxidizing system,[5-8] has been studied. The objectives were to study (*a*) the structural requirements for a compound to act as auxin synergist in rooting and (*b*) the effects of such chemicals on the levels of exogenously applied auxins, activity of IAA-oxidizing system and penetration and transport of auxins in cuttings, in relation to adventitious root formation.

Experiments were carried out on cuttings of 12 days old seedlings of *Phaseolus vulgaris* L. cultivar "Tender green" which had been raised under controlled conditions. The method of Gorter was followed for rooting of cuttings.

Indole, α- and β-naphthols, pyrogallol and coumarin promoted rooting in absence of auxins. Figure 1 shows that indole greatly synergised rooting induced by IAA, IBA (γ-indole butyric acid), and NAA. Both the naphthols synergised rooting induced by all the auxins; α-naphthol being more effective than β-naphthol. Cinnamic acid also enhanced the root-promoting effects of the auxins. *Para*-hydroxy benzoic acid and salicylic acid synergised rooting by IBA and NAA, ferulic acid proved to be an effective synergist of

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[*] Present address: University College of Agriculture, Calcutta University, 35, Ballygunge Circular Road, Calcutta-19.

IBA. Pyrogallol, though highly effective alone, antagonised the auxin effects. Most of the polyphenolic compounds antagonised rooting of 2, 4-D-treated cuttings. Although indole was synergistic to IAA and IBA, the naphthols to NAA, and 2, 4-dichlorophenol (DCP) to 2, 4-D, the synergists also synergised rooting by auxins structurally unrelated to them. This confirms the views of Gorter that synergism does not merely depend on a close resemblance in the molecular structure of the synergists and the compounds synergised.

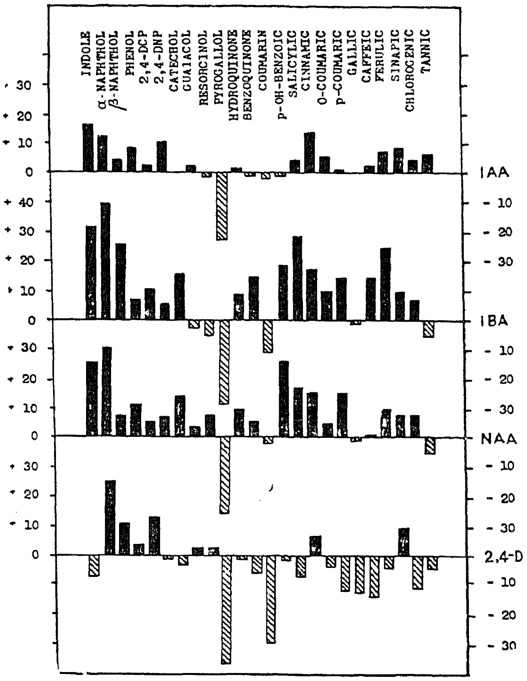

FIG. 1. Histograms showing increase (solid bars) or decrease (hatched bars) in number of roots per cutting due to synergism or antagonism [values obtained by subtracting individual effects of auxins and synergists or antagonists from mean auxin-*cum* synergist or antagonist effects, + (*plus*) denotes synergism, − (*minus*) denotes antagonism]. Concentration of IAA 10^{-4}, IBA and NAA 5×10^{-5} and 2, 4-D $2 \cdot 5 \times 10^{-6}$ M. Synergists or antagonists at 10^{-3}, except DCP 2×10^{-4}, DNP 5×10^{-5}, tannic acid 10^{-4}, catechol, salicylic and cinnamic acids at 5×10^{-4} M.

The structural requirements for a phenolic compound to stimulate rooting as stated by Hess are not satisfied by *para*-hydroxy benzoic and salicylic acids since both of these monophenolic acids synergised rooting by IBA and NAA in French bean cuttings. Moreover, in *p*-hydroxy benzoic acid the *para* position is not free. *Para*-hydroxy benzoic and salicylic acids also synergised rooting by IAA and NAA in cuttings of *Eranthemum tricolor* Nichols.[9]

Samples of cuttings taken 24, 48, and 120 hours after treatment with carboxy labelled IAA (3-indole acetic acid-1-C^{14}) indicated that more radiocarbon was present in tissues in the presence of catechol, pyrogallol, guaiacol, α- and β-naphthols, *p*-benzoquinone, hydroquinone and gallic, chlorogenic, sinapic, caffeic, ferulic and tannic acids than in their absence. Radiocarbon content after treatment with indole and coumarin was similar to that of control. These results point out that extent of rooting was not related to total radiocarbon content in tissues. Radioactivity in the tissue was, however, not confined to IAA only. Autoradiograms of extracts of IAA-1-C^{14}-treated cuttings showed the presence of four radioactive compounds (unidentified). The same compounds were found after treatment with different synergists but minor differences were observed in relative intensities of the spots under the different treatments. Radiocarbon content of NAA-1-C^{14} and 2, 4-D-1-C^{14}-treated cuttings was not much affected by the phenolics or other chemicals tested.

Preparations of IAA-oxidase from bean tissues were incubated with IAA-1-C^{14} and a range of different substances. Enzyme activity was greatly inhibited by all the polyphenolics tested, and also by α- and β-naphthols, *p*-benzoquinone and hydroquinone. Indole did not effectively inhibit IAA-oxidase. IAA-oxidase preparations from *Phaseolus*, however, failed to oxidise NAA-1-C^{14} or 2, 4-D-1-C^{14}, and addition of an IAA-oxidase cofactor like DCP or inhibitor like α-naphthol did not have any effect on the levels of these auxins in the incubation mixture (Table I).

The contentions of van Raalte and Gorter that indole acts through inhibition of IAA-oxidase are not supported by the present findings. Although autoradiograms of labelled auxin-treated cuttings showed incorporation of C^{14} into a number of compounds, may be in part, due to refixation of $C^{14}O_2$, IAA-oxidase of *Phaseolus* has shown good specificity. Unlike IAA-1-C^{14}-treated cuttings, total radiocarbon in NAA-1-C^{14} and 2, 4-D-1-C^{14} treatments was unaffected by the IAA-oxidase inhibitors. The question of an inductive synthesis[10] of an oxidizing enzyme system during rooting is, however, not clear. Even after five days when root initiation was well advanced, no reduction in total radiocarbon of NAA-1-C^{14} and only slight reduction in 2, 4-D-1-C^{14}-treated cuttings could be observed but by that time a large fraction of radioacti-

TABLE I

Specificity of Phaseolus *IAA-oxidizing system*

	Residual radioactivity (CPM) in incubation mixture of labelled auxins under different treatments after 6 hrs. at 28° C. (α-Naphthol, Indole and DCP, all at 10^{-4} M)			Radioactivity (CPM) in samples of labelled auxins treated cuttings (α-Naphthol-5×10^{-4} DCP-10^{-5} and Indole 10^{-3} M)		
	IAA-1-C^{14}	NAA-1-C^{14}	2,4-D-1-C^{14}	*IAA-1-C^{14}	**NAA-1-C^{14}	*2, 4-D-1-C^{14}
Control (no stimulator or inhibitor)	443	941	595	840	704	1,275
α-Naphthol	812	931	586	1,944	719	1.251
DCP	450	925	600	834	707	1,274
Indole	465	914	585	896	733	1,268
Control (killed enzyme)	801	923	579	..	..	..

* 24 hours after application.
** 48 hours after application.

vity of these auxins was distributed to a number of unidentified compounds.

The synergism of the different chemicals with the auxins cannot therefore be explained merely by assuring that the synergists prevent oxidation of the auxins by IAA-oxidase.

The question of differential uptake of auxins under the different synergistic chemicals was not a major factor in the present experiment as the cuttings were allowed to draw the whole of the solution supplied. Transport of 2, 4-D-1-C^{14} within the cutting was, however, greater as compared with IAA-1-C^{14} or NAA-1-C^{14}; the latter moved particularly slowly. Some minor differences in the movement of auxins were found in the presence of the synergistic chemicals. Differences in penetration and translocation of auxins in cuttings cannot, therefore, be major reasons of root-promoting effects of all synergistic chemicals.

It is suggested that metabolic reactions other than those mediated by the IAA-oxidizing system are involved in synergism. Whether the auxins become biologically more active by forming addition products with the chemicals (*vide* Leopold and Plummer[11]) remains to be seen. Identification of the compounds into which the radiocarbon from the labelled auxins was found to be incorporated and the study of their role in rooting seem to be fruitful lines of study.

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LETTERS TO THE EDITOR

UNSEEDED GROWTH OF TELLURIUM SINGLE CRYSTALS FROM THE MELT

SINGLE crystals of tellurium have been grown from the melt by Lovell *et al.*[1] and Chiang.[2] Chiang[2] could get good crystals only with the help of a horizontal zone-refining furance and discusses the difficulty experienced in growing single crystals of tellurium by using a vertical Bridgman furnace. We report here some of our observations on the growth of tellurium single crystals from the melt.

Efforts were made to grow tellurium single crystals by the Bridgman method using a vertical furnace. But the resulting ingots were found to be polycrystalline, with needle-shaped crystals arranged conically about the axis of the container. Chiang[2] has also made a similar observation.

A horizontal moving-furnace arrangement was then used. The furnace was 14 cm. in length and the metal was held along its axis in an evacuated Pyrex tube. The arrangement is similar to the horizontal moving-furnace assembly discussed by Goss.[3] The furnace had a gradient of 30° C./cm. at 500° C. The furnace could be moved at different speeds by coupling it to a motor through suitable gears. Single crystals with a semicircular cross-section of 10 mm. diameter were obtained. Several such crystals are shown in Fig. 1. One face of these crystals is a cleaved face. The crystals shown in the photograph are 2–3 cm. in length. However, quite often crystals 6–8 cm. in length were grown. Attempts to grow crystals with a larger cross-section were not very successful.

There are divergent views regarding the preferred orientation of unseeded single crystals. Grinberg[4] observed that the orientation of cadmium crystals depends to a great extent upon the growth rate. Similarly, in the case of zinc, Balasubramanian[5] observed that at slow rates of growth the basal plane is perpendicular to the growth axis, while at faster rates, the same plane is oriented parallel to the mould axis. However, in the course of his studies of the growth of bismuth, Shah[6] observed that the orientation of unseeded bismuth crystals was independent of the growth rate. He observed that at all growth rates the orientation was the same and was such that the direction of maximum thermal conductivity was parallel to the growth axis.

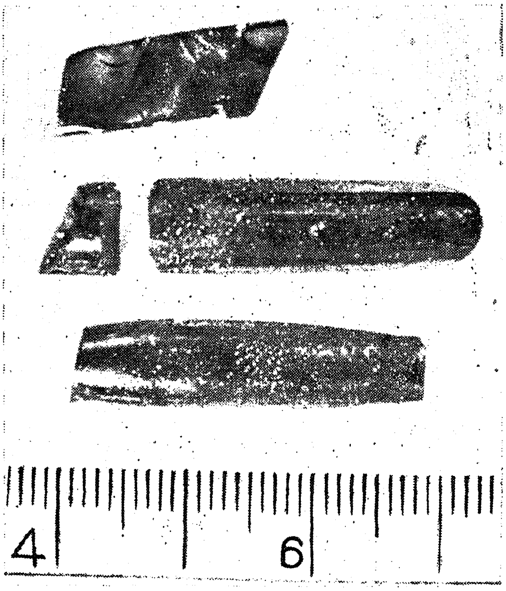

FIG. 1. Single crystals of tellurium (Scale in cm.).

We have grown tellurium single crystals at growth rates of 2 cm., 4 cm., 6 cm., 10 cm. and 15 cm. per hour. Several crystals were grown at each growth rate. The resulting single crystals were cleaved and the angle between the cleavage plane $(10\bar{1}0)$ and the growth axis (the axis of the ingot) was measured. The angle was in the range of 45–80°. While this angle varied from crystal to crystal, it was always within the range given above and no systematic correlation was observed between the speed with which the furnace was moved and the angle between the cleavage plane and the growth axis. Thus, as in the case of bismuth, the orientation is the same at slow and fast rates of crystal growth. However, it was observed that the quality of the cleaved surface was better in the case of crystals grown at slower rates than in the case of crystals grown at fast rates.

As mentioned above, the cleavage plane makes an angle of 45–80° with the growth axis. This orientation is similar to the orientation of tellurium crystals grown by Chiang[2] at much smaller growth rates and also similar to the orientation of selenium (which is isomorphous with tellurium) crystals grown by Harrison and Tiller.[7] This means that the [0001] direction which lies in the cleavage plane $(10\bar{1}0)$, makes a large angle with the growth axis. The coefficient of thermal conductivity parallel to the *c*-direction is much larger than that for a perpendicular direction ($K_{\perp}/K_{\parallel} = 0{\cdot}6_6$, Wooster[8]). If the orientation of unseeded single crystals is solely dependent on the anisotropy of thermal conductivity, the cleavage plane of tellurium, which contains the direction of maximum thermal conductivity, should align itself parallel to the growth axis. But such an orientation is at variance with what is actually observed. Thus, the anisotropy of thermal conductivity does not seem to be the only factor governing the orientation of unseeded crystals grown from the melt.

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Physics Department, D. B. SIRDESHMUKH.
Post-Graduate Centre,
Warangal (A.P.),
and
Physics Department, K. G. SUBHADRA.
Osmania University,
Hyderabad-7, *August* 16, 1969.

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ROTATIONAL ANALYSIS OF THE VISIBLE A-X SYSTEM OF THE BeI MOLECULE

IN a previous note,[1] a doublet system of bands of the BeI molecule has been vibrationally analysed and attributed to a $^2\Pi$-$^2\Sigma$ transition with a doublet separation of 373 K. Assuming that the upper $^2\Pi$ state is a regular state, the long wavelength (0, 0) sub-band is ascribed to a $^2\Pi_{\frac{1}{2}}$-$^2\Sigma$. This sub-band which is headless and most intense reveals the presence of the band origin and unresolved R_1, Q_1, P_1 and $^{O}P_{12}$ branches even under low dispersion of the Hilger three-prism glass Littrow Spectrograph. The rotational structure of this band has been examined in the second order of a 21 ft. concave grating spectrograph (0·62 Å/mm.) with a view to confirm the nature of the transition and to determine the rotational constants of the zero vibrational levels of the upper and the lower states of the sub-system.

As the spin orbit coupling constant A is large, it is reasonable to assume that the upper $^2\Pi$ state belongs to Hund's case (*a*). In a $^2\Pi_{\frac{1}{2}}$-$^2\Sigma$ transition the following branches are expected $^{O}P_{12}$, P_1, $^{P}Q_{12}$, Q_1, $^{Q}R_{12}$ and R_1. For a headless band, as in the present case, the Q_1, $^{Q}R_{12}$ and R_1 branches are expected to lie on the shorter wavelength side, while the P_1, $^{P}Q_{12}$ and $^{O}P_{12}$ branches occur on the longer wavelength side of the band origin. Under the dispersion used, all the above branches are completely resolved. Since it is known that the separation of P_1 and $^{P}Q_{12}$ branches (and also Q_1 and $^{Q}R_{12}$) is due to the doubling of the levels of the $^2\Sigma$ state, and that the separation of the lines having the same K values should be proportional to $K + 1/2$, it was at once possible to assign J values to the lines of these branches. The J numbering in the other two branches is fixed by applying the combination relation

$$Q_1(J) - {}^{O}P_{12}(J+1) = R_1(J) - {}^{P}Q_{12}(J+1) = F_2''(J+1) - F_1''(J).$$

A comparison of the combination differences involving R_1, Q_1 and P_1 branches revealed the presence of an appreciable combination defect. From a detailed rotational analysis of the (0, 0) sub-band, it has been confirmed unambiguously, that the sub-band arises from a $^2\Pi_{\frac{1}{2}}$-$^2\Sigma$ and that the upper state of the A-X system of BeI is a regular $^2\Pi$ state. This conclusion is further supported by the identification of the first Q_1 (1/2) and P_1 (3/2) lines. The rotational constants of the $X^2\Sigma$ and $A^2\Pi_{\frac{1}{2}}$ states are summarised in Table I.

TABLE I

The rotational constants of the $X^2\Sigma$ and $A^2\Pi$ states of the BeI molecule

$X^2\Sigma$	$A^2\Pi_{\frac{1}{2}}$
$B_0 = 0{\cdot}4577$ cm.$^{-1}$	$B_0 = 0{\cdot}4569$ cm.$^{-1}$
$D_0 = 10{\cdot}31 \times 10^{-6}$ cm.$^{-1}$	$D_0 = 9{\cdot}53 \times 10^{-6}$ cm.$^{-1}$
$H_0 = 11{\cdot}1_8 \times 10^{-10}$ cm.$^{-1}$	$H_0 = 9{\cdot}7_3 \times 10^{-10}$ cm.$^{-1}$
$\gamma_0 = 0{\cdot}0463$ cm.$^{-1}$	$p_0 = -0{\cdot}021$ cm.$^{-1}$
$I_0 = 61{\cdot}14 \times 10^{-40}$ g. cm.^{2}	$I_0 = 61{\cdot}24 \times 10^{-40}$ g. cm.$^{-2}$
$r_0 = 2{\cdot}092$ Å	$r_0 = 2{\cdot}094$ Å
	$A_0 = 357{\cdot}2$ K

The ground state $X^2\Sigma^+$ of BeI molecule can be attributed to the configuration..

$$\ldots.\ (z\sigma)^2\ (y\sigma)^2\ (w\pi)^4\ (x\sigma)\ \ldots.\ {}^2\Sigma^+$$

The first excited $A^2\Pi$ state can be attributed to the configuration..

$$\ldots.\ (z\sigma)^2\ (y\sigma)^2\ (w\pi)^4\ (v\pi)\ \ldots.\ {}^2\Pi r.$$

Spectroscopy Laboratory, P. SREENIVASA MURTY.
Department of Physics, P. TIRUVENGANNA RAO.
Andhra University,
Waltair, *August* 7, 1969.

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PREPARATION OF $TlMnF_3$

PREPARATION of $TlMnF_3$ by reacting TlF with MnF_2 in aqueous solution has been reported.[1,2] Recently, Eastman and Shafer prepared this compound by reacting TlF in HF solution with stoichiometric MnF_2 and evaporating the mixture to dryness. The product was purified by heating at 500–600° C. in HF. An easier method of preparation of $TlMnF_3$ is to crystallise it by concentrating the dilute HF solution of MnF_2 and TlF in the molar ratio of 1 : 1·6. If the reactants are taken in 1 : 1 molar ratio the resulting $TlMnF_3$ is found to be contaminated with MnF_2. The purity was checked by X-ray powder method.

The chemicals used in this preparation were B.D.H. (A.R. or L.R. Grade). Polyethylene vessels were used.

MnF_2 was prepared as follows:

Ammonium carbonate solution was added to $MnSO_4.4H_2O$ dissolved in distilled water. The resulting manganese carbonate was filtered, thoroughly washed free of solvent, transferred into a polyethylene beaker and dissolved in 20% HF solution by warming on a water-bath.

The TlF solution was prepared by dissolving the corresponding carbonate in 20% HF on a water-bath.

The $TlMnF_3$ was prepared by mixing MnF_2 and TlF solutions in molar ratio of 1 : 1·6 and evaporating the solution on a water-bath until crystals of $TlMnF_3$ were formed. They were filtered, washed with 20% HF solution and finally dried on a water-bath. $TlMnF_3.1/6\ H_2O$: Tl, calculated 64·0%, found 64·6%; Mn, calculated 17·2%, found 16·2%; F, calculated 17·8%, found 18·0%.

I am grateful to Dr. J. Shanker for providing laboratory facilities,

Chemistry Division, T. S. SRIVASTAVA.*
Bhabha Atomic Research
Centre, Trombay,
Bombay-85, *August* 25, 1969.

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* Present address: Department of Chemistry, The University of Chicago, Chicago, Illinois 60637.

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SYNTHESIS OF N-ARYL-N′-2-(4-ARYL THIAZOLYL)-N″-METHYL (OR H) GUANIDINES

THIAZOLE derivatives have been reported to act as fungicides,[1] local anaesthetics[2] and antituberculars.[3] Recently, Bhargava and co-workers have synthesised several substituted benzothiazolyl guanidines and have evaluated them as antibacterials,[4] antituberculars[5,6] and algæcides.[7] This led us to synthesize some new N-aryl-N′-2-(4-aryl thiazolyl)-N″-methyl (or H) guanidines.

In this communication, 2-amino-4-*p*-tolyl thiazole[8] was condensed with aryl isothiocyanates.[9] The resulting thiazolyl thiocarbamides were desulphurized with yellow lead oxide in the presence of ethanolic ammonia or ethanolic methyl amine.

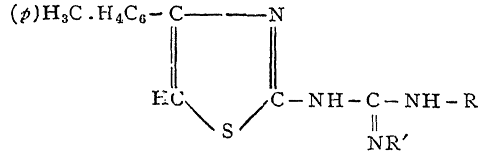
Experimental.—N-Benzyl - N′ - 2 - (4 - p - tolyl thiazolyl) thiocarbamide was prepared by the method of Bhargava *et al.*[4] in 85% yield, m.p. 234° C. (Found: N, 12·23; S, 18·91. $C_{18}H_{17}N_3S_2$ requires N, 12·39; S, 18·88%).

Similarly, other N-aryl-N′-2-(4-aryl thiazolyl) thiocarbamides have been prepared by S. C. Sharma.[3]

N-Benzyl-N′-2-(4-p-tolyl thiazolyl) guanidine.—N-Benzyl-N′-2-(4-*p*-tolyl thiazolyl) thiocarbamide (1·5 g.), yellow lead oxide (2 g.) and ethanolic ammonia (15 ml.) were heated in a glass autoclave on a water-bath for 10–12 hours. After cooling, the autoclave was opened carefully, and the product was boiled with ethanol (50 ml.) and filtered hot. The filtrate on cooling gave beautiful crystals. It was recrystallised from ethanol. Similarly, other N-aryl-N′-2-(4-*p*-tolyl thiazolyl)-N″-alkyl (or H) guanidines have been prepared. Their yields, melting points and analytical data are listed in Table I.

TABLE I

N-Aryl-N′-2-(4-p-tolyl thiazolyl)-N″-alkyl (or H) guanidines



No.	R	R′	Yield %	M.P. °C.	Mol. Formula	Nitrogen %	
						Found	Calcd.
1	Benzyl	H	63	156–8*	$C_{18}H_{18}N_4S$	17·21	17·39
2	*p*-Tolyl	H	46	132–4	$C_{18}H_{18}N_4S$	17·28	17 39
3	*p*-Chlorophenyl	H	50	191†	$C_{17}H_{15}N_4SCl$	16·12	16·35
4	*p*-Ethoxyphenyl	H	47	168	$C_{19}H_{20}N_4OS$	15·73	15·92
5	Benzyl	CH_3	70	227	$C_{19}H_{20}N_4S$	16·70	16·66
6	*p*-Tolyl	CH_3	65	142–3	$C_{19}H_{20}N_4S$	16·41	16·66
7	*p*-Chlorophenyl	CH_3	60	180	$C_{18}H_{17}N_4SCl$	15·91	15·71
8	*p*-Ethoxyphenyl	CH_3	65	138	$C_{20}H_{22}N_4OS$	15·45	15·30

* Starts Shrinking at 85° C.
† Starts shrinking at 140° C.

N-o-Tolyl-N′-2-(4-phenyl thiazolyl-N″-methyl guanidine was prepared in a similar manner as described above, using ethanolic methyl amine solution (10 ml.). It was crystallised from ethanol, m.p. 140–41°, yield 45% (Found: N, 17·21; S, 10·07. $C_{18}H_{18}N_4S$ requires N, 17·39; S, 9·94%).

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Department of Chemistry,
Faculty of Science,
Banaras Hindu Univ.,
Varanasi-5, *April* 28, 1969.

P. N. BHARGAVA.
M. R. CHAURASIA.
R. LAKHAN.

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KINETICS OF ADSORPTION OF CARBON MONOXIDE AND HYDROGEN MIXTURES ON IRON FISCHER-TROPSCH CATALYSTS AT DIFFERENT TEMPERATURES

THE change in the composition of the adsorbed phase at various intervals of time has been investigated employing two Fischer-Tropsch iron catalysts:

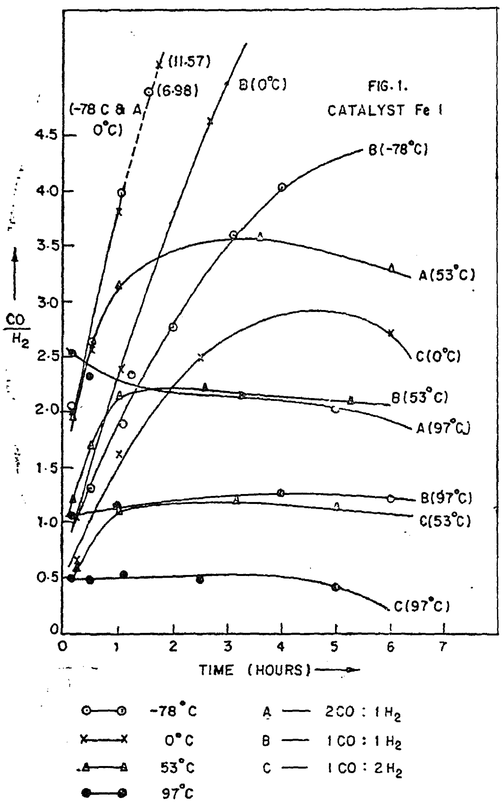
Fe 1 (Fe : MgO : SiO_2 : Cr_2O_3 :: 91·8 : 6·2 : 1·0 : 1·0) and
Fe 2 (Fe : MgO : SiO_2 : Cr_2O_3 : K_2O :: 91·1 : 6·2 : 0·9 : 0·9 : 0·9)

with three different mixtures of carbon monoxide and hydrogen having the volumetric composition of 2 CO : 1 H_2 (A), 1 CO : 1 H_2 (B) and 1 CO : 2 H_2 (C). The kinetic studies have been carried out at – 78° C., 0° C., 53° C. and 97° C. with a view to ascertaining the effect of temperature on the composition of the adsorbed phase.

A known volume (about 15 c.c.) of the gaseous mixture was allowed to come into contact with a definite weight (5·4 g.) of the catalyst previously reduced with hydrogen at 400° C. and degassed at the same temperature at 10^{-5} mm. Hg for 8 hrs. The pressure and the composition of the equilibrium gaseous mixture at various intervals were determined by a calibrated mercury manometer and a kathatometer respectively in a conventional B.E.T.

set-up. The dead space of the system was determined by the helium method for each catalyst. From the data, the composition of the adsorbed phase at various intervals of time was calculated at each temperature. After determining the kinetic curve for a given mixture, the catalyst was reduced with hydrogen and the kinetic curve for the next mixture was determined.

Results.—The results given in Fig. 1 for the iron catalyst Fe 1 show that to start with, the composition of the adsorbed phase is practically equal to the composition of the gas phase employed. At low temperatures (— 78° C. and 0° C.), the CO/H_2 ratio in the adsorbed phase continuously increases with an increase in time. At 53° C., however, the CO/H_2 ratio in the adsorbed phase reaches a maximum value in about 2–3 hours and the value then falls as the time of contact is increased. At 97° C., there is very little change in the composition of the adsorbed phase beyond one hour showing a rapid attainment of equilibrium. The kinetic curves at — 78° C., 0° C. and 53° C. for Fe 2 (Fig. 2) are similar in nature to those obtained for Fe 1, but the CO/H_2 ratio for a given mixture is always higher with Fe 2 than with Fe 1. Even at 97° C., the CO/H_2 ratio is very much higher for Fe 2 as compared with Fe 1 with a slight negative slope for the kinetic curves.



F G. 1

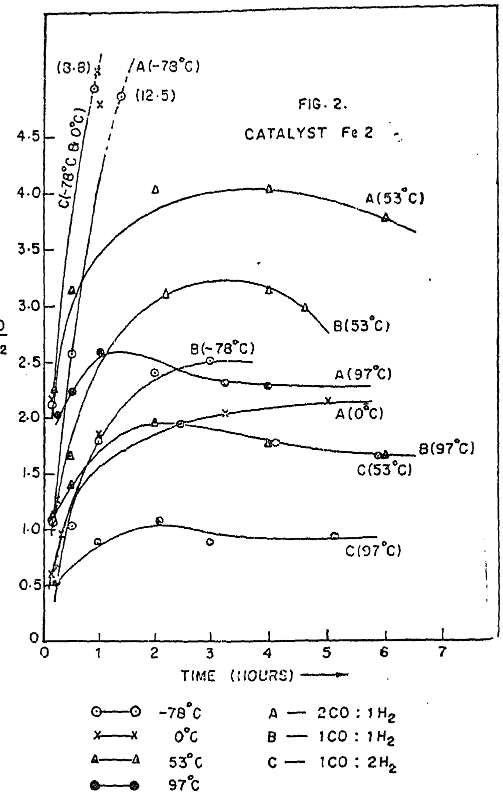


FIG. 2

The presence of alkali in Fe 2 not only enhances the CO/H_2 ratio in the adsorbed phase but also brings about rapid equilibrium conditions particularly at elevated temperatures. These two factors are responsible for the production of hydrocarbons of higher molecular weight in Fischer-Tropsch synthesis in the presence of iron catalysts containing alkali. This observation is in consonance with literature reports (for *e.g.*, Storch, Goulombic and Anderson, *Fischer-Tropsch and Related Syntheses*, John Wiley and Sons, New York, 1951 and Anderson, R. B., *Catalysis*, Vol. IV, pp. 47, 123, 219, 331). It has also been noticed in syntheses at 200° C. conducted by the present authors that Fe 2 gives hydrocarbons of higher molecular weight as compared with Fe 1 where methane is the predominant hydrocarbon formed. Hence it is inferred that alkali as a promoter in iron catalysts has a decisive influence on the adsorption of carbon monoxide and hydrogen and also the nature of the products obtained in Fischer-Tropsch synthesis.

Dept. of Inorganic and
Physical Chemistry,
Indian Institute of Science,
Bangalore-12, India,
September 2, 1969.

K. Subramanyam.
M. R. A. Rao.

A KINETIC STUDY OF THE CERIUM (IV) + VANADIUM (IV) SYSTEM IN PERCHLORIC ACID MEDIUM

Since cerium(IV) salts are extensively employed in analytical chemistry, an understanding of the mechanism of oxidation of inorganic and organic compounds by cerium (IV) salts is highly desirable. The kinetics of oxidation of Fe(II),[1] Sn(II),[2] Tl(I),[3] Hg(I),[4] U(IV)[5] and Mn(II)[6,7] have been investigated previously. Recently, kinetic study of oxidation of V(IV) with Ce(IV) in sulphuric acid medium has been reported.[8] The difficulty in the potentiometric titration of V(IV) with Ce(IV) which has been previously attributed to the sluggishness of the main reaction is shown to be due to the sluggishness in the attainment of potentials by the indicator electrode. Since the titration of V(IV) with Ce(IV) was found to be possible by Smith and Getz[9] in 8 M $HClO_4$ medium using potentiometric method the kinetics of this reaction have been investigated. The results are reported in this note.

Experiments were performed using Beckman DBG spectrophotometer equipped with a thermostat and a photovolt recorder. Cerium (IV) perchlorate solutions were obtained from G. F. Smith and Company and vanadyl perchlorate solutions were prepared from vanadyl sulphate and barium perchlorate. Reagent grade perchloric acid and sodium perchlorate were used in all studies. The decrease in the absorbance of cerium(IV) at 340 mμ is followed in monitoring the course of the reaction. Since vanadium(V) also absorbs to a small extent at this wavelength the observed absorbance values were corrected for the contribution of vanadium(V) to obtain the absorbance due to Ce(IV) alone. The results fitted well with a second-order rate equation and a typical plot of the rate data is given in Fig. 1. The results of some experiments are given in Table I.

Table I

Kinetic data for (IV) and V (IV) reaction:
$HClO_4$ = 1·00 M : T = 25° C.; 340 mμ

Concentration of Ce (IV) mM	0·91	1·09	1·46	0·55	0·36	0·91
Concentration of V (IV) mM	0·71	0·71	0·71	0·71	0·71	1·06
Rate constant L M^{-1} S^{-1}	62·0	62·6	60·5	64·7	66·6	65·2

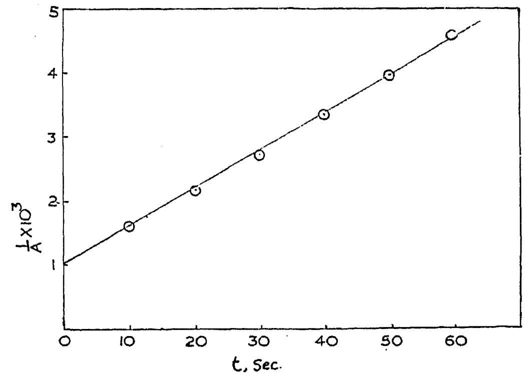


Fig. 1. Plot of 1/A *vs.* time for cerium (IV), vanadium (IV) reaction. Cerium(IV) = vanadium (IV) = 0·81 mM. Perchloric acid = 1·00 M; T = 25° C.

The second-order rate constant was found to be 62·0 ± 5·0 LM^{-1} S^{-1} in one molar perchloric acid at 25° C. From the results obtained at 5° C., 15° C. and 25° C. the activation energy was calculated as 12·0 ± 1·0 Kcals. Experiments carried out by varying the perchloric acid concentration (from 0·5 to 2·0 M.), keeping the ionic strength constant at 2, indicated that the rate increases with increase in acidity.

The rate of the reaction was found to increase with increase in ionic strength from experiments conducted in presence of 0·5 M $HClO_4$ and varying amounts of sodium perchlorate (0·5 to 2·0 M). Further, the rate also increased with increase in perchloric acid concentration when the ionic strength was not kept constant.

From a spectrophotometric study of cerium (IV) in perchloric acid medium, Hardwick and Robertson[10] concluded that the main species were $Ce(OH)^{3+}$, Ce^{4+}, and Ce-O-Ce, the dimer occurring in very small amounts. The main species of vanadium(IV) in perchloric acid medium is reported to be VO^{2+} by Rossotti and Rossotti.[11] The oxidation of vanadium (IV) by cerium (IV) occurs by two paths one involving Ce^{4++} and VO^{2+} and the other involving $CeOH^{3}$

and VO^{2+}. The increase in rate with increase in acidity is related to the different rates with which the two species of cerium(IV) react with vanadium(IV). If the rate involving Ce^{4+} is higher than that with $CeOH^{3+}$ an increase in acidity will result in increased rate of the reaction since the concentration of Ce^{4+} increases with acidity. The reported ease in the titration of V(IV) by Ce(IV) in 8 M $HClO_4$ is thus due to the increase in rate of oxidation with increase in acidity and ionic strength.

It is interesting to notice the large difference in the rate of oxidation of V(IV) by Ce(IV) in presence of perchloric acid (62 LM^{-1} S^{-1} in 1 M $HClO_4$ at 25° C.) and sulphuric acid (1350 LM^{-1} S^{-1} in 1 M H_2SO_4 at 25° C. Uranium(IV) is also reported to be more rapidly oxidized in sulphuric acid medium than in perchloric acid medium. However, the opposite behaviour is observed in the oxidation of Fe(II), organic compounds,[12] and Cr(III).[13] This is presumably due to the different cerium(IV) species present in the two media the anionic $Ce(SO_4)_3^{=}$ and $Ce(SO_4)_2$ predominating in the sulphuric acid solutions. Other factors, for instance VO^{2+} getting oxidized to VO_2^+ and U^{4+} to UO_2^{2+} both involve an increase in the number of oxygen atoms in the oxidized species, may be also important.

Chemistry Department, G. NAGESWARA RAO.
Indian Institute of
Technology,
New Delhi-29, *July* 28, 1969.

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ACIDITY DEPENDENCE IN THE OXIDATION OF α-PHENYL ETHYL ALCOHOL BY VANADIUM (V) ION

REACTIONS in moderately concentrated mineral acids have recently been classified by Bunnett[1] into three categories. The plots of log $k + H_0$ against log a_{H_2O} are generally linear and the slopes define a parameter 'ω'. A 'ω' value of $-2 \cdot 5$ to 0 indicates non-participation of water in the transition state (typically carbonium ion reactions exhibit this behaviour), a value between $+1 \cdot 2$ and $+3 \cdot 3$ that water acts as a nucleophile and a value $> 3 \cdot 3$ that water acts as a proton transfer agent. Investigating the oxidation of 2-hydroxy-2-methyl propionic acid by vanadium(V), Mehrotra[2] obtained a 'ω' value of 4·2 for reactions in perchloric acid and a value of 5·3 in sulphuric acid and has proposed that a water molecule behaves as a proton-abstracting agent in the rate-determining step. The value of ω was, however, between 2·3 and 2·7 in the vanadium(V) oxidation of butane-1, 4-diol in perchloric acid indicating that a water molecule acts as a nucleophile.[3] We present in this communication, the results of our investigation on the effect of varying sulphuric acid concentration on the vanadium(V) oxidation of α-phenyl ethyl alcohol.

The reaction was carried out in 50% HOAc-50% H_2O (v/v) as solvent at 50° C. with [ROH] = 0·03 M and [vanadium(V)] = 0·015 M. The reaction was followed by estimating the unreacted vanadium(V) at various time-intervals by a modified procedure earlier suggested by us.[4] The reaction is of a total second order, first with respect to both the alcohol and vanadium(V). It is evident from Table I that the reaction is profoundly affected by acidity. Indeed there exists a linear relationship between log k and log [H^+] in the region 0·75 M to 3·0 M (Fig. 1) above which the linearity does not hold. The slope of this line is 2 showing that the active oxidant is most probably $V(OH)_2^{3+}$ or $V(OH)_2(HSO_4)^{2+}$. The

TABLE I

[Alcohol] = 0·03 M Temp. 50° C.
[Vanadium (V)] = 0·015 M Solvent: 50% $\overline{HOAc}$

[H^+]	$k_2 \times 10^4$ litre-mole^{-1}sec.$^{-1}$
0·75 M	3·60
1·0 M	6·33
1·5 M	11·6
2·0 M	19·5
3·0 M	62·1
4·0 M	211
4·5 M	536

plot of the rate constant against the square of sulphuric acid concentration (upto 3 M) also produces a straight line confirming that the order of reaction with respect to sulphuric acid is 2 within this range.

The plot based on Bunnett's correlation of the rate with the activity of water is shown in Fig. 1. The values of $-H_0$, the Hammett acidity function have been taken from Paul and Long's review[5] and the a_{H_2O} values are those reported by Bunnett.[1] The least square slope of the line in the figure is + 2·0 indicating that a water molecule is involved in the transition state as a nucleophile. The observed value of ω certainly rules out the function of the water molecule as a proton-abstracting agent, as was suggested in a recent proposal by Bakore and Ramashanker in the vanadium (V) oxidation of benzyl alcohol.[6] The alternative mechanism of these authors—a modified hydride abstraction mechanism simulating a push-pull type of S_N2 mechanism is not wholly valid because vanadium (V) oxidations of alcohols proceed through a prior complex formation.[7] We, therefore, propose the following transition state for the oxidation of an alcohol by vanadium (V) (Fig. 2).

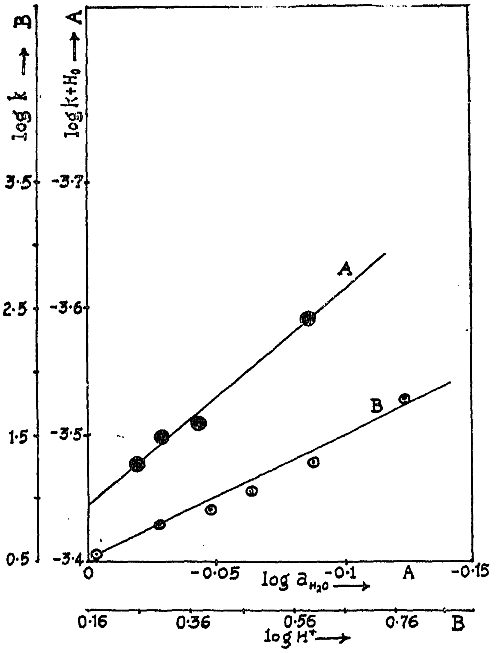

FIG. 1

This would explain the observed ω which will be the resultant of two competing steps of opposite character (*viz.*, the production of a carbonium ion with a large negative value of ω and a nucleophilic participation of a water molecule with a positive ω). Incidentally, we confirm the earlier observation of Ramashanker and Joshi[8] that the reaction does not exhibit any free-radical character in that no induced reduction of mercuric chloride could be observed during the course of the reaction. The reaction also does not induce the polymerization of acrylonitrile or allyl acetate.

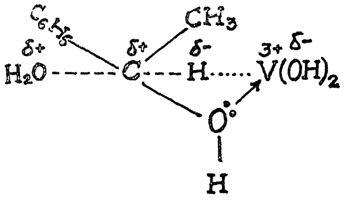

FIG. 2

Dept. of Chemistry, B. GANAPATHYSUNDARAM.
Vivekananda College, N. VENKATASUBRAMANIAN.
Mylapore, Madras-4, *July* 31, 1969.

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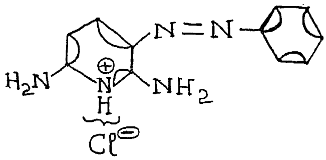
ANALYTICAL APPLICATIONS OF 2:6-DIAMINO-3-PHENYLAZOPYRIDINE MONOHYDROCHLORIDE (PYRIDIUM) SELECTIVE DETECTION OF PHOSPHATE, BISMUTH, ANTIMONY AND MERCURY

2 : 6-DIAMINO-3-PHENYLAZOPYRIDINE monohydrochloride (Pyridium) (I) is a brick-red-coloured, water-soluble azo dye, generally used as a urinary antiseptic in the treatment of genito-urinary tract infections.[1,2] Its solution in water is yellowish-orange in colour; the colour changes to red or reddish-orange on acidification.[3] Although the synthesis of this medicinal dye was reported long ago by Chichibabin and Zeide,[3] the work on the investigation of its applications has since been confined almost exclusively in the field of therapeutics. Shupe[4] in 1933 reported a characteristic microchemical reaction of

pyridium with 5% potassium thiocyanate solution, which yielded characteristic crystals, best recognised from photomicrographs. Yalcindag[5] in 1950 also reported a similar type of reaction of pyridium with 10% sodium nitrite solution at 20°, and observed characteristic crystals or a crystalline precipitate (specific for an amino group attached to an heterocyclic ring); the crystals were identified under a microscope. After the work of Yalcindag, there has been apparently no further development regarding the use of pyridium, directly or indirectly, in chemical analysis.



I

The present communication is an attempt to introduce certain interesting, hitherto overlooked, applications of pyridium into chemical analysis. The dye has been found to be a specific, selective, and highly sensitive reagent for the phosphate ion, and a novel qualitative reagent for bismuth(III), antimony(III), and mercury(II) ions. A thick, deep red-coloured precipitate (probably of pyridium molybdophosphate) is formed when a very minute quantity of phosphate, in solid or solution form, is added to an acidified solution of pyridium to which ammonium molybdate solution has been added. The red precipitate is soluble in caustic soda solution, giving a light yellowish-green solution. Oxalic acid solution also dissolves it, and in consequence, the test fails in the presence of oxalate. No other anion (including arsenate) and cation interfere. It has thus proved a novel test for the detection of traces of phosphate in arsenates.

Dilute aqueous solutions of pyridium give a beautiful, heavy, bright pink-coloured precipitate with bismuth(III), and an orange or pinkish-orange precipitate with antimony(III). Mercury(II) at pH ~ 7 causes a colour change of a dilute aqueous solution of pyridium from yellowish-orange to deep orange or reddish-orange, which on adding a drop or two of caustic soda solution gives a red or reddish-violet precipitate. The following procedures are recommended for the detection of various ions using pyridium:

Detection of Phosphate.—Take 2 ml. of a 5% aqueous solution of ammonium molybdate, add 2 drops of concentrated hydrochloric acid, and heat the solution to boiling. Then add 2 ml. of 0·1% aqueous solution of pyridium and a small quantity (or 1–2 drops of an aqueous or acidic solution) of the test sample. Immediate formation of a deep red precipitate indicates the presence of phosphate. The precipitate settles down on cooling and keeping for 2–3 minutes.

Limit of detection: $1\ \gamma\ PO_4^{3-}$.

In the absence of phosphate, there appears no precipitate, yet the colour of the solution is reddish-orange (which is the usual colour of an acidic pyridium solution).

Detection of Bismuth (III).—Dissolve a little of the substance to be tested in 2–3 ml. of concentrated hydrochloric acid, and add an equal volume of a 0·1% pyridium solution to it. Pour the resultant solution into a beaker containing about 100 ml. of water. In the presence of bismuth, a heavy, beautiful, bright pink and voluminous precipitate will be formed. The brightness of the precipitate decreases after several minutes.

No other common cation save antimony(III) interferes.

Limit of detection: 1 mg. Bi^{3+}.

Detection of Antimony (III).—The procedure is the same as described for bismuth(III). The precipitate obtained in case of antimony is either pale orange or pinkish-orange. The precipitate caused by antimony is soluble in excess of sodium hydroxide solution, while that of bismuth is insoluble, but turns yellowish in colour.

Limit of detection: 1 mg. Sb^{3+}.

Only bismuth interferes with the test.

Detection of Mercury (II).—Add a drop of a mercury salt solution (pH ~ 7) to 2 ml. of 0·1% aqueous solution of pyridium. The yellowish-orange colour of the pyridium solution turns red or reddish-orange. Then add 1 or 2 drops of 4 *N* caustic soda solution. The formation of a deep red or reddish-violet precipitate indicates mercury(II).

Limit of detection: $500\ \gamma\ Hg^{2+}$.

No common cation of the six groups of the qualitative analytical scheme interferes with the test, with the exception of Bi^{3+} and Sb^{3+}.

Department of Chemistry, G. S. Johar.
V.S.S.D. College,
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PRODUCTION OF FLAVOURING PRINCIPLES BY TISSUE CULTURE OF *CORIANDRUM SATIVUM*

THE methodology employed to establish *in vitro* plant tissue cultures has been well documented.[1] Many investigators have since speculated on the possible application of plant tissue cultures for producing economically useful plant constituents. Some medicinal compounds have been reported to be produced by static or suspension cultures of plant tissues. Thus, production of cardic glucosides by tissue cultures of *Digitalis lanata* and *Digitalis purpurea*,[2] nicotine from *Nicotiana tabacum* L.,[3] tropane alkaloids from *Datura* sp.[4] and vinca alkaloids from *Catharanthus roseus* L.[5] have been recently reported. The seeds and leaves of the *Coriandrum sativum* plant are most extensively used throughout India to flavour various dietary preparations. Our interest, in the establishment of the tissue culture of *Coriandrum sativum*, was to see if the flavouring principles present in the natural plant are also synthesized by the callus tissues.

Seeds of *Coriandrum sativum* were sterilized with 5% sodium hypochlorite solution, washed with sterile distilled water and germinated under aseptic conditions. Roots germinated under sterile conditions were used for callus growth. White's medium,[6] containing 0·7% agar and supplemented with 15% coconut water (V/V), 4 mg./lit. of 2, 4-dichlorophenoxyacetic acid (2, 4 D) and 4 mg./lit. of indole acetic acid (IAA), was the most satisfactory medium for callus tissue growth. A healthy callus tissue with a maximum weight of 465 mg. was obtained in 8 weeks, which was started with an initial weight of 25 mg. on the above medium. White's medium without any supplementation could not, however, support the growth.

Seven to eight-week old callus tissues were collected from several flasks. Ten grams of the callus tissue was extracted with 50 ml. of ether in cold and the ether extract was concentrated in vacuum. The concentrated callus extract was then spotted on TLC plates using silica gel G. and 5% ethyl acetate in benzene as developing solvent. Pure samples of linalool, borneol, geraniol, α- and β-pinene and p-cymene were also spotted as standards. These compounds are associated with the flavouring principles of coriander oil.[7] The developed plates were sprayed with 10% solution of antimony pentachloride in carbon tetrachloride and were warmed at 100° for a few minutes. The callus extract showed the presence of geraniol, with R_f value matching exactly with that of the standard geraniol sample spot. None other flavouring principles could be detected in the callus extract. The ability of coriander root callus to biosynthesize geraniol could thus be established. Mention could be made that volatile flavouring compounds associated with lemon,[8] peaches,[9] and mints[10] were not reported present in their respective static plant tissue cultures.

Department of Chemical Technology,
University of Bombay,
Matunga Road,
Bombay-19, *July* 28, 1969.

D. L. SARDESAI.
H. P. TIPNIS.

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CATION EXCHANGE CAPACITY OF BASALTIC SOILS OF MALWA PLATEAU

CATION Exchange Capacity (C.E.C.) is one of the properties used in the characterisation of soils. This property is usually associated with the mineral and organic colloidal constituents ($< 2\mu$) of the soils. Hosking[1] arrived at an average value of 280 m.e. per 100 g. of organic carbon in soils.

TABLE I

Cation exchange capacity of the soil and its size fractions*

Soil No.	Nature of soil	Depth (inches)	Soil	Silt (2–20 μ)	Clay (< 2μ)
7	Dark grey ..	10–15	66·0	56·3 (10·8)‡	105·4 (63·2)‡
15	Reddish-brown ..	60–70	87·6	85·0 (20·8)	100·7 (34·3)
16	Weak-red ..	70+	78·0	82·3 (24·6)	108·6 (21·7)
23	Yellowish-brown ..	3–12	44·6	53·8 (9·7)	92·4 (31·9)
32	Dark grey (Black) ..	14+	39·6	56·7 (4·3)	108·5 (19·9)
33	Reddish-brown (Lateritic) ..	0–7	25·9	36·5 (3·6)	51·7 (20·2)
36	Black ..	0–6	60·6	58·1 (9·4)	95·7 (50·4)
38	Reddish-brown (Lateritic) ..	5–10	34·7	40·6 (5·7)	67·5 (32·1)

* C.E.C. was measured by the modified ammonium acetate method.[5] ‡ The values in parentheses indicate the contributions of the various size fractions to the C.E.C. of the soils.

In the course of a study of the genesis of basaltic (red and black) soils of Malwa Plateau, high cation exchange capacity of the soils, varying from 25 to 88 m.e. per 100 g., is observed. The soils have very low organic matter (average 0·5%) to account for the observed C.E.C. The C.E.C. of a few typical soils and their clay and silt separates is given in Table I. The results in Table I clearly bring out that the C.E.C. of some of the soils (Nos. 15, 16 and 32) cannot be explained by taking into consideration the contribution from silt and clay fractions of the soils. The mineralogy of the silt and clay size fraction of the soils, as determined by X-ray analysis, indicated the predominance of smectites in both the clay and silt fractions. This is in conformity with the observations of McAleese and Mitchell[2] that the seat of the high cation exchange capacity in the silt fraction does not lie in the silt-sized clay minerals and cannot be attributed to incomplete dispersion of the soil. There is thus an indication that coarser fractions definitely contribute to the C.E.C. of soils. Such a possibility was reported earlier in Australian and Ireland soil.[1-4]

Indian Agricultural Research Institute,	K. V. S. SATYANARAYANA.
New Delhi-12,	B. P. SAHI.
July 24, 1969.	G. S. R. KRISHNA MURTI.

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A NOTE ON MEGA AND MICROSPORE REMAINS FROM THE TERTIARY COAL OF MALAYA

THE Malayan coal has been generally regarded as unfossiliferous. Some Dutch workers investigated this coal, but they could not recover any fossils. The present study, however, has revealed that the coal is highly fossiliferous. Coal samples were collected by one of us (B. S. T.) in 1954 from near Kuala Lumpur, Malaya. Fungi from this coal were earlier described by Trivedi and Chaturvedi (1961). The coal on maceration yielded large number of microspores, cuticles, megaspores, fungal bodies and insect remains. A few spores representing the various groups of plants are described here.

DESCRIPTION

FUNGI: *Brachysporium* sp. (Fig. 1)

Spores two to several celled, somewhat cylindrical in shape, 30 × 15 μ in size, upper two cells are more dense, basal cell gradually narrower, ending in a short stalk, cross-wall thick, 3 μ in width, apex rounded, spore wall 1 μ wide, surface smooth.

BRYOPHYTA: *Sphagnum* sp. (Fig. 2)

Spore 20 × 23 μ in size, triangular, with round corners, rays reach the equator, spore has slight thickening of the wall beyond the ends of trilete arms, rays 7–13 μ in length, spore wall 0·5–1 μ thick, surface smooth, brown in colour.

PTERIDOPHYTA: *Anemia* sp. (Fig. 4)

Spore triangular in shape, anterior side somewhat pointed, 53 × 60 μ in size, exine 1·5–2 μ thick, surface echinate and striated, striations unbranched rarely branched, 3–4 μ thick, numerous and closely packed, space between two striæ narrow, trilete læsuræ narrow and not reaching the periphery.

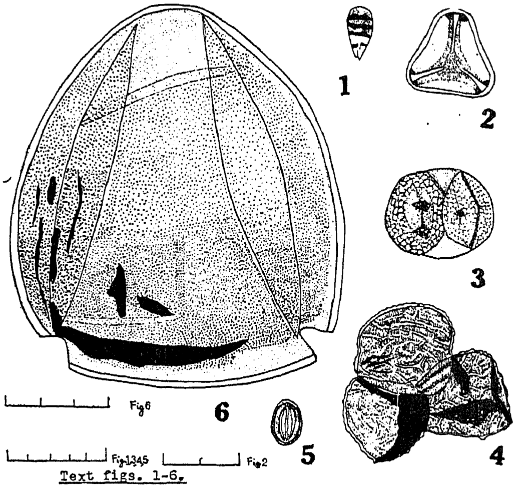
GYMNOSPERM : *Podocarpus* sp. (Fig. 3)

Body of the pollen grain circular in outline, 56 × 53 μ in size, exine 1–1·5 μ thick, smooth and granular, two bladders usually bent towards the centre of the pollen grain, bladders quite large and reticulate.

ANGIOSPERM : *Quercus* sp. (Fig. 5)

Grains small spherical or somewhat oblately flattened in outline, Furrows longitudinal, comparatively narrow, grains widest at the equatorial plane, exine 1–1·5 μ thick, covered with very small warts.

MEGASPORE : *Calamospora* sp. (Fig. 6)



FIGS. 1–6. Fig. 1. *Brachysporium* sp. Fig, 2. *Sphagnum* sp. Fig. 3. *Podocarapus* sp. Fig. 4. *Anemia* sp. Fig. 5. *Quercus* sp. Fig. 6 *Calamospora* sp.

Spore large, round to spherical, 960 × 1120 μ in diameter, interapical sides convex, exospore 16 μ thick, finely granular, forming a mat-like structure, trilete sutures obscure, lips open, læsuræ each 820 μ long reaching more than half the spore body, folds present.

Department of Bitany, B. S. TRIVEDI.
Lucknow University, C. L. VERMA.
Lucknow, *July* 29, 1969.

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CALORIMETRY WITH REFERENCE TO A TROPICAL FISH

IN this note we discuss the calorific estimations made by three well-known direct methods to study the energy turnover in a tropical fresh-water fish *Ophiocephalus punctatus*. In the first method an oxygen bomb calorimeter manufactured by a firm in India was used. The instrument was a plain jacket (diabatic), single valve calorimeter similar to the well-known Parr bomb.[1] The two other methods are : (1) that by Vinberg *et al.*[2] as modified by Ivlev,[3] and (2) that by Karzinkin and Tarkovskaya.[4]

In the last two methods, known also as wet combustion, the weight of sample used is as low as 8 to 10 mg. of dry material which is a great advantage, particularly for work on micro-organisms where the amount of material available for estimation is a crucial factor.[4] Between the two wet methods Karzinkin's method is direct and does not involve, as in Ivlev's method, a separate estimation of protein on account of its incomplete combustion. We are unable to know from the reference available to us whether, in fact, this is true of Karzinkin's method itself. Contrary to this claim the values obtained by Ivlev's method are higher by 1·5 to 4% over the other (*vide* Table I). Further, although slightly involved, in Ivlev's method one has to collect data on protein level in the material, which is itself a useful information to have on hand. However, when both the sets of values were compared with those of the oxygen bomb, it was found that the latter values were between 11 and 16% higher than the values of Karzinkin's method.

TABLE I

Test material	Calories per gram dry weight of ash-free material		
	Oxygen bomb method	Karzinkin's method	Ivlev's method
Ophiocephalus ..	5301·842	4499·014	4568·120
do. (after feeding)	5686·032	5035·076	5154·502
Fæces ..	3908·380	3317·570	3437·636

When the three methods are compared the oxygen bomb method is certainly advantageous because of its accuracy. Contrary to what was indeed claimed by Karzinkin, minute planktonic organisms weighing between 5–10 mg. have been used in the oxgen bomb itself by Comita and Schindler[5] burning them together with the millipore membrane in which they were filtered. Philipson[6] has even developed a microbomb for reducing the weight of material used. Further, when minute samples of a large animal such as fish were employed in the wet methods as in the present case, there were wide variations in the values obtained from aliquots of the same material. It is suggested that this may be due to the difficulty of getting and burning calorifically homogeneous material. A slightly greater proportion of fish scale or some such calorifically poor material in the sample could show a definite lowering of results when employed in the wet methods. At least in Ivlev's method the estimation of protein separately and the correction factor employed do reduce this error somewhat. However because of the advantages of the oxygen bomb method and for want of the Philipson bomb an attempt was made in this study to reduce the weight of sample by seeding a known quantity of benzoic acid with the material. In this manner reproducible results were obtained by reducing the weight of sample to 200 mg. from the usual 1 g. minimum. With even more precise control over the initial temperature of the water in the bucket and keeping that of the water in the jacket also constant, it is possible to reduce the sample weight low enough to obtain the caloric values of smaller organisms as was done by Comita and Schindler.[5]

Thus it will be seen from the above that the wet combustion methods give lower values than the oxygen bomb values. Although the wet combustion methods apparently have the advantage of permitting relatively minute samples being tested, a modification of the oxygen bomb technique itself by seeding known amounts of benzoic acid with minute quantities of the sample appears to give a break-through in this snag of minimum weight of sample in the oxygen bomb.

Dept. of Biological Sciences, S. V. Job.
Madurai University, V. M. Gerald.
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POND-SNAKE AND GROUND SQUIRREL AS PARATENIC HOSTS OF *ASCAROPS STRONGYLINA*

Coprophagous beetles act as vectors of the swine stomach worm, *Ascarops strongylina*. Encysted spirurid larvæ found in two species of dung-beetles, dragonfly, hedgehog, domestic fowl and duck, were given orally to twenty rabbits by Ono[3] who recovered, from the stomach wall of three rabbits, fully developed specimens of *A. strongylina*. The larval form, collected from the stomach wall and mesentery of red bat by Alicata and McIntosh[1] was fed to a rabbit and, a month later, adults were recovered. The encysted larvæ described from the stomach wall of bat by van Beneden (1873) and Ono (1932) were also believed to be identical to the form recovered by them. From 10 out of 14 species of dung beetles examined locally, Chowdhury and Pande[2] collected encysted larvæ of this stomach worm. Infection experiments with rabbit and guinea-pig yielded adults and re-encystment, in the gastric wall of rabbit, was also reported.

During an examination of a specimen of the pond-snake, *Natrix piscator*, for helminth parasites, the stomach wall and mesentery revealed minute white cysts which, on teasing, liberated infective spirurid larvæ. The excysted juveniles, when examined alive and after clearing of the preserved specimens, proved to be identical to those described from the dung-beetles.[2] This identification was confirmed by feeding the cysts to two clean laboratory-bred rabbits.

Pieces of the infected tissue harbouring a large number of cysts were fed to one rabbit and 40 cysts were administered to the second. The droppings were regularly examined after the 35th day of the infection. Typical eggs of *A. strongylina* were detected on the 41st day of the infection. One of the rabbits, on autopsy conducted the same day, yielded five adult worms—two males and three females. From the second rabbit slaughtered on 45th day, a large number of adult males and females were recovered. On morphological characters and in the size-ranges, these specimens were clearly assignable to *A. strongylina*.

During the examination of 11 specimens of the ground squirrel, *Funambulus palmarum*, similar cysts were once encountered in the stomach wall. Their specific identity was also confirmed by administering 12 cysts to a clean laboratory-bred rabbit which, autopsied on 62nd day of infection, yielded three sexually mature worms—a female and two males.

The present finding of encysted larvæ of *A. strongylina* in a checkered keelback and a ground squirrel is evidently a first record and adds an ophidian and a rodent among the known second intermediaries of this cosmopolitan parasite of pigs.

Grateful acknowledgement is due to Dr. B. P. Pande, Professor of Parasitology, for his constant supervision and going through the manuscript and to the Indian Council of Agricultural Research for the award of Senior Research Fellowship in Helminthology.

Department of Parasitology, V. P. GUPTA.
U.P. College of Veterinary
Science and Animal Husbandry,
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PLANT MICROFOSSIL EVIDENCE ON THE AGE OF DALMIAPURAM GREY SHALE, DISTRICT TRICHINOPOLY

RECENTLY, one of us (Subbaraman, 1968)[1] has dealt in great detail the geological aspects of the Grey Shale bed at Dalmiapuram, District Trichinopoly, South India. Stratigraphically it is unconformably over and underlain by the Uttaturs and the Hornblende Gneiss respectively. But recently, we have observed in the mines that Grey Shale bed does not directly overlie the Archeans but unconformably upon the sandstone and conglomerate bed of probably Upper Gondwana age. The age of the Dalmiapuram Grey shale has long been a matter of controversy due to the lack of any fossil evidence. Subbaraman (*l.c.*) assigned a Pre-Uttatur age whereas Sastri and Raiverman (1968, p. 147)[2] consider it as a black shale of Lower Cretaceous (Albian) age. Both have based their observations on geologic grounds.

The present material was collected from the northern lime-stone quarry at Kallakhudi along a fault. The shale samples are fragile and grey in colour. The purpose of the present paper is to record the conclusions arrived at, concerning the age of these grey shales based on the palynological data. The detailed taxonomic account will be dealt separately.

The palynological assemblage recovered from the Grey Shale sample contains a mixture of 35% miospores (pteridophytic spores, gymnosperm pollen grains). A detailed systematic taxonomic treatment of the analysed assemblage reveals the presence of the following taxa. At present mostly the generic identifications are referred with a few important species of distinction, used in correlation and determination of age problems.

MIOSPORES

Pteridophytic spores

1. *Converrucosisporites* spp.
2. *Acanthotriletes* spp.
3. *Krauselisporites* spp.
*4. *Taurcusporites* spp.
5. *Cicatricosisporites* spp.
6. *Verrucosisporites* spp.
7. *Lycopodiumsporites* spp.
8. *Cyatheacidites* spp.
*9. *Contignisporites dettmanni* Singh and Kumar (1966).
*10. *C. glebulentus* Dettmann (1963).
*11. *Appendacisporites cristatus* (Markova) Pocock (1964).
*12. *Triletes tuberculiformis* Cookson (1947).
13. *Cyathidites minor* Couper (1953).
*14. *Hymenozonotriletes mesozoicus* Pocock (1962).
*15. *Appendacisporites erdtmani* Pocock (1964).

Gymnospermous pollen-grains

16. *Podocarpidites* spp.
17. *Sphæropollenites* spp.
18. *Triangulopsis trilobatus* (Balme) Jain (1969).

Microplanktons

19. *Gonyaulacysta* spp.
*20. *Cyclonephilium distinctum* Deflandre and Cookson (1955).
21. *Hystrichosphæridium* spp.
22. *Hystrichosphæra* spp.
23. *Oligosphæridium complex* (White) Davey *et al.* (1966).
24. *Baltisphæridium* spp.
25. *Palæoperidium* sp.
26. *Chlamydophorella* sp.

From the above list of genera and species it is quite evident that the pteridophytic spores are mainly schizæaceous whereas gymnosperm pollen-grains are podocarpaceous. The orcurrence of *Classopollis complex* is rare. The angiosperms are totally absent. The identification of microplanktons reveals the dominance of *Hystrichosphœridium complex*.

The above-mentioned characteristics of the present assemblage closely compare with the Lower Cretaceous palynomorphs of Onepah station in north-western New South Wales described by Deflandre and Cookson (1955, p. 294),[3] and the Albian "Green Sands" microflora of Baltes (1967).[4] The miospores with an asterisk listed above are so far known to occur in the Lower Cretaceous and younger formations. The present assemblage can be compared well with the other known Lower Cretaceous assemblages described by Cookson and Eisenack (1960, 1962),[5–6] Pocock (1962),[7] Dettmann (1963),[8] Singh *et al.* (1964)[9] and Singh (1964),[10] etc., from different parts of the world.

Recently, Hedlund and Norris (1968)[11] have recorded an interesting palynological assemblage from Albian strata, Marshall County, Oklahoma. It contains a good representation of schizæaceous elements along with 17% angiospermic pollen-grains. The occurence of undoubted angiospermic remains are recorded from Albain (Brenner, 1967).[12] Archangelsky and Gamerro (1967, p. 217)[13] have therefore, placed the Patagonia assemblage at the top of Aptian only because of the absence of typical angiospermis. The above statement precludes an Albian age for the grey shale assemblage.

In view of the above comparisons, presence and absence of certain elements and the overall picture of the palynological spectrum suggests a Lower Cretaceous probably Aptian age for the Dalmiapuram Grey Shale assemblage. It also indicates that the sediments were deposited under brackish water of conditions.

Birbal Sahni Institute of K. P. Jain.
Palæobotany, Lucknow,
and
Dalmia Cement (B) Ltd., J. V. Subbaraman.
Dalmiapuram, Madras, *July* 29, 1969.

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DOUBLE ROWS OF INTER-PROGLOTTIDAL GLANDS IN *MONIEZIA EXPANSA*

Double rows of inter-proglottidal glands in Moniezia species have earlier been reported by Durrani and Hameed[1] (1967). During the course of routine examination, a case of double rows of interproglottidal glands was encountered in *Moniezia expansa*, from a sheep of non-descriptive type.

The morphological features of the mature segments were similar to those of *M. expansa*, except the double rows of interproglottidal glands one behind the other in the posterior half, each row consisting of 17 to 22 glands which were saccular and arranged in pits.

In the material from goats at Lyallpur of Pakistan, Durrani and Hameed (*op. cit.*) noticed a constant number of 23 in each row, one at the anterior and the other at the posterior borders. In the present case, from sheep of Andhra Pradesh in India, the number varied from 17 to 22 in each row, one row at the posterior border and another just above it. Inter-proglottidal glands in Moniezia are of taxonomic importance (Yamaguti,[2] 1959). The significance of this finding whether constituting a separate entity is under investigation.

The authors are greateful to Dr. P. S. Rajulu, Principal, Dr. Ganti A. Sastry, Dr. A. Venkataratnam and Mr. M. Emaduddin for their encouragement and help.

Dept. of Pathology N. Satyanarayanacharyulu.
and Parasitology, T. Subbarao.
College of Vet. Sci., K. James Christopher.
Tirupati (A.P.), *July* 21, 1969.

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REVIEWS AND NOTICES OF BOOKS

Introduction to Commutative Algebra. By Michael F. Atiyah and L. G. Macdonald. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. ix + 128. Price 70 *sh.*

This book grew out of lectures given to third year undergraduates at Oxford University and is intended to provide a rapid introduction to the subject of commutative algebra. It is designed for the student who has had a first elementary course in general algebra.

It is not intended as a substitute for the more voluminous tracts on the subject but concentrates on certain central topics and, following the modern trend, puts more emphasis on modules and localization. The authors have adopted the use of homological methods—exact sequences, diagrams, etc.—but stopped short of any results requiring a deep study of homology, thereby preparing the ground for a systematic course on homological algebra.

The contents of this book are: Rings and Ideals; Modules; Rings and Modules of Fractions; Primary Decomposition; Integral Dependence and Valuations; Chain Conditions; Noetherian Rings; Artin Rings; Discrete Valuation Rings and Dedekind Domains; Completions; and Dimension Theory. C. V. R.

Lectures on Ordinary Differential Equations. By Hille. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. xi + 723. Price 163 *sh.*

Intended for courses at the graduate or advanced graduate level, this book stresses the theory of ordinary differential equations. All of the topics treated have figured in lectures given by the author over a period of forty-five years at Harvard, Princeton, Yale, and other leading universities. Using this text, a variety of courses may be taught at the graduate level.

The book is divided into three parts: Part I gives the general theory, Part II is devoted to linear second-order equations, and the brief Part III deals with some non-linear problems in the complex domain. The emphasis is on the behaviour in the complex domain and the extension of the classical results to abstract valued solutions. The prospective reader should have had an introductory course in differential equations as well as good grounding in linear algebra and real and complex analysis.

Part I contains the following chapters: Preliminaries; Existence and Uniqueness Theorems; *Appendix A*—Some Differential Equations of Function-Theoretical Significance; Variation of Data; Abstract Spaces; Linear Differential Equations with Almost Constant Coefficients; *Appendix B*—Linear Differential Equations in the Complex Domain; Linear Differential Equations in Banach Algebras; and *Appendix C*—Riccati's Equation.

Part II contains the following chapters: Special Linear Second Order Differential Equations; Sturm-Liouville Theory; Solutions on the Real Line; Singular Boundary Value Problems; and Complex Oscillation Theory.

Part III contains the following chapters: *Appendix D*—The Schwarzian; and Non-linear Differential Equations in the Complex Domain.

C. V. R.

An Introduction to Matrices and Linear Transformations. By John H. Staib. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1969. Pp. xii + 336. Price 59 *sh.*

This book is introductory in nature, and is designed primarily as a one-semester sophomore text in linear algebra for engineering and science students. The author has developed the material using a class-room style presentation, with all its informality and experimentation. Theoretical concepts are lavishly illustrated both by examples and by computational type exercises that relate directly to the theory. Many of the exercises are multipart ones that are designed to bring the student to the threshold of a discover which he can then make for himself. The subject-matter has been divided into sections in such a way that a pace of one section per class meeting can be regularly maintained.

The contents of this book are: Matrices; Vectors; Linear Transformations; The Determinant Function; and Euclidean Spaces.

C. V. R.

Annual Review of Medicine (Vol. 20). Edited by Arthur C. DeGraff. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306), 1969. Pp. viii + 499. Price $ 8.50, U.S.A. and $ 9.00. Foreign.

The contents of this volume are: Pathological Alterations in Blood Flow; The Natural History of Congenital Isolated Pulmonic and Aortic Stenosis; The Structure of the Spleen and Hemolysis; The Defective Red Blood Cell in Hereditary Spherocytosis; Platelet Lifespan; Acquired Inhibitors of Coagulants; Immune Processes and Infectious Factors in Central Nervous System Disease; Membrane Potential and Muscle Function; Technetium-99 M in Clinical Nuclear Medicine; Cellular Hypersensitivity; Immunoglobulins; Human Histocompatibility Antigens of Leukocytes; Neurosurgical Control of Pain; Bacteriology of Acne; Glucagon; Mechanism of Action of Aldosterone; Magnesium Deficiency; Cell Division in Normal Mammaliam Tissues; Glomerular (Azotemic) Osteodystrophy; Hemodynamic Studies in Portal Hypertension; Gastrin and Gastric Secretion; Nephritogenic Streptocccci; Virulence of Gonococci; The Epidemiology of St. Louis Encephalitis: A Review; Chlamydial Infection in Reiter's Syndrome; The Role of Bacteriophages in Bacterial Resistance to Antimicrobials; Renal Tubular Acidosis; Ureteral Motility; Intrarenal Blood Flow; The Psychopharmacology of Hallucinogenic Agents; Diagnosis of Suicidal Intent; Sequential Analysis in Therapeutic Trials; and Assisted Respiration. C. V. R.

The Directory of Scientific Research Institutions in India. By T. S. Rajagopalan and R. Satynanrayana. (Indian National Scientific Documentation Centre, Delhi-12), Pp. 1120. Price: India Rs. 75·00, U.S.A. $ 30.00, others £ 10.00.

This arduous undertaking by the INSDOC is the outcome of a recommendation of the Research and Industry Get-together held in 1965, and it ably fulfils a much wanted need. The *Directory* gives basic information on nearly a thousand institutions devoted to scientific research and development in India.

The compilation is based on questionnaire sent out to all institutions in the country and coming under the scope of this survey. Nearly 80% had responded. Thus the information is authentic and up-to-date.

The Institutions are grouped under the following sections: Council of Scientific and Industrial Research; Indian Council of Agricultural Research; Indian Council of Medical Research; Defence Research and Development Organisation; Atomic Energy Commission; Central Government Institutions; State Governments Institutions; Academic Institutions and Universities; Co-operative Research Associations; Research and Development Public Sector and Private Sector; and Commonwealth Institutions and others.

Under each Institution the following information is given: Name, Address, Director, Year of Establishment, Research Staff, Library, Divisions, Field Stations, History, Functions, Achievements, Fields of Research, and Special Facilities. The *Directory* contains a series of well-prepared Indices to facilitate its use.

The *Directory* will be of great use to scientists, administrators, planners, and international organisations. The Director, INSDOC and the compilers deserve compliments for successfully executing a responsible, and by no means light, task. A. S. G.

Books Received

Introductory College Mathematics with Business Applications. By K. C. Skeen, C. W. Wheeler and R. L. Johnson. (Addison-Wesley Publishing Co., Inc., London W. 1), 1969. Pp. viii + 456. Price 70 *sh.*

Degradation of Herbicides. Edited by P. C. Kearney and D. D. Kaufman. (Marcel Dekker, Inc., New York, N.Y. 10016), 1969. Pp. xi + 394. Price $ 18.75.

Physics Experiments and Projects (Vol. 5). By W. Bolton. (Pergamon Press, Inc., Headington Hill Hall, Oxford), 1969. Pp. xvii + 121. Price: Hard cover 18 *sh.*; Flexi cover 9 *sh.*

Elementary Solid State Physics for Students of Science and Engineering (Part I). By R. Ramaswamy. (Mrs. Lakshmi Ramaswamy, C 37, Tirunagar, Madurai-6), 1969. Pp. 163. Price Rs. 6·00.

Encyclopedia of Library and Information Science (Vol. 2). By Allen Kent and Harold Lancour. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1969. Pp. ix + 707. Price $ 45.00.

Fundamentals of Statistics. By H. Mulholland and C. R. Jones. (Plenum Publishing Corporation, New York 10016), 1969. Pp. x + 291. Price $ 5.95.

Elementary Statistics. By G. Hadley. (Holden-Day, Inc., 500, Sansome St., San Francisco 94111), 1969. Pp. xx + 457. Price $ 9.75.

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BLUE DELPHINIUMS AND THE PURPLE BIGNONIA

SIR C. V. RAMAN

ABSTRACT

The spectroscopic behaviours of two flowers are described and discussed, illustrating respectively the optical properties of Florachromes A and B.

THE present article is intended to supplement the studies published in recent issues of *Current Science* on the nature and origin of floral colours. It deals with two flowers which exhibit vivid colours but which are totally different. The observations make it evident that in one of them, the colours arise from the presence of Florachrome A and in the other they are ascribable to the presence of Florachrome B.

Delphinium belladonna is a perennial bloomer of great beauty. Its flowers appear arranged on vertical spikes, each spike carrying several flowers. If the central spike is cut off as soon as it has finished flowering, the side shoots will flower. The material thus remains available for study for a considerable period. As the petals are not very thick, the most satisfactory procedure for observing their spectroscopic behaviour is to hold two of them together and view them against a strong light. The spectrum of the transmitted light exhibits three dark bands, the first of which centred at 630 mμ is the strongest: the second at 580 mμ is also well pronounced but not completely dark. The third band at 540 mμ is also visible but it is much feebler than the others. Under the small dispersion provided by the viewing spectroscope, the visible spectrum presents the appearance of *three bright bands*, which are respectively red, orange-yellow and green separated by the dark absorption bands in the positions stated above. The wavelengths beyond 500 mμ come through quite freely. The spectrum is thus characteristic of florachrome A, and is observed with all blue flowers.

Bignonia magnifica is a large bushy shrub which grows vigorously and bears flowers in great profusion. The flowers are of considerable size, and as each individual bush or plant can at any time carry a great number of them, it presents a magnificent sight. The colour of the flowers is a reddish-purple which is richest when the flower has just opened to its full extent. Later, the colour fades noticeably. The most satisfactory way of examining its spectroscopic behaviour is to hold two petals of the freshly opened flower together and examine light from a strong source which has passed through the pair. It will then be seen that the wavelengths greater than 600 mμ and also the wavelengths less than 500 mμ come through freely. But the region from 560 mμ to 600 mμ is strongly absorbed and the region from 500 mμ to 560 mμ also appears much reduced in intensity. At high levels of illumination, the wavelengths between 560 mμ and 600 mμ which include the yellow sector are the brightest part of the spectrum. *Bignonia magnifica* thus provides an excellent illustration of the role played by the yellow sector in the perception of colour, and especially of the fact that its exclusion from the spectrum results in the production of the purple sensation. It is also evident from the observations that the floral pigment functioning in *Bignonia magnifica* is Florachrome B, since the characteristic absorptions of this florachrome appear in the yellow and green sectors of the spectrum leaving the red sector entirely unaffected.

Extraction of the Floral Pigments.—Immersing the flowers of delphinium in either water or acetone produces no observable effect. It is necessary to grind the petals to a fine paste in an agate mortar using a small quantity of acetone as a lubricant. After pouring out the surplus acetone and squeezing out what is left, water is added to the paste which results from the grinding, and the mix is then stirred up and filtered through a cotton-wool plug. The result of these operations is a bright blue solution containing the material responsible for the colour of the flower. A spectrophotometric record of the absorption of light by this extract contained in a cell of one-centimetre thickness is reproduced as Fig. 1.

The numbers shown in the figures are the wavelengths in angstrom units. The record exhibits a comparatively free transmission of the shorter wavelengths in the blue region of the spectrum, while the strong absorptions in the yellow and orange regions are responsible for the intense blue which is the colour actually perceived.

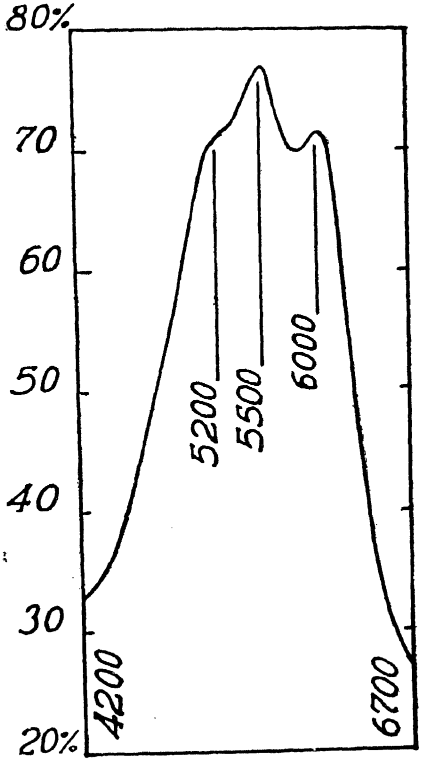

FIG. 1. Absorption by Delphinium extract.

The colouring matter is readily extracted from the petals of *Bignonia magnifica* by the aid of acetone, with a little pressure in an agate mortar. The acetone extract is vividly coloured and a visual examination of the light transmitted through it through a spectroscope shows the absorption bands in the yellow and the green regions of the spectrum which are characteristic of Florachrome B, while the blue and red sectors are freely transmitted. A spectrophotometric record of the absorption by the extract is reproduced as Fig. 2.

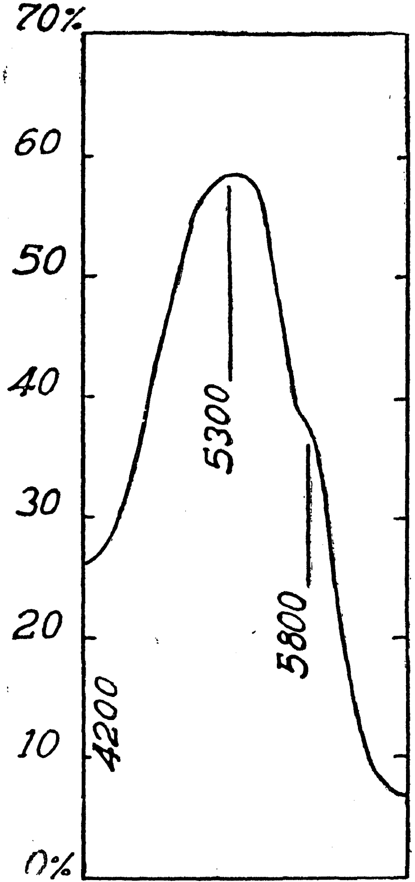

FIG. 2. Absorption by Bignonia extract.

The spectrophotometric studies of the extracts were made in the Instruments Section of the Indian Institute of Science, to whose authorities the thanks of the author are due.

STUDIES ON ORGANO-METALLIC INTERACTIONS IN THE MARINE ENVIRONMENT

Part 1. Interaction of Some Metallic Ions with Dissolved Organic Substances in Sea-Water

ELIZABETH KOSHY, M. V. M. DESAI AND A. K. GANGULY
Health Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-85 (AS), India

ABSTRACT

The role of dissolved organic matter in the marine environment in complexing the metallic elements present at tracer levels has been studied. Dissolved organic matter obtained from a filtrate from a marine culture solubilized Mn, Zn, Fe and Zr-Nb. Mn and Zn formed cationic complexes or were attached to the organic complex as exchangeable cations, while Fe and Zr-Nb, in part, were either 'non-ionic' or 'anionic'.

INTRODUCTION

MANY dissolved elements occur in trace quantities in sea-water. At the pH of sea-water and in the presence of major inorganic chemical constituents, however, bi-, tri- and tetravalent elements, such as zinc, iron and zirconium, precipitate.

Sillen,[1] while discussing the different chemical states of trace elements dissolved in sea-water, noted that organic compounds at concentrations of 10^{-5} M to 10^{-4} M may form strong complexes (*cf.* also Goldberg[2]) with certain metal ions, and that these organic complexes might contribute largely to some of the elements present at the very low concentrations of 10^{-6} M to 10^{-7} M. Goldberg[2] speculated on the possible complexing of the heavier lanthanides, whose concentrations are of the order of 10^{-10} M to 10^{-11} M, by soluble organic debris. In discussing the recovery of vanadium by precipitation with $Fe(OH)_3$, Burton[3] noted the possibility that vanadium, in the form of organic complexes, may not be recovered by the procedure. The presence of a non-dialyzable, yet ultrafilterable, fraction of manganese and zinc in sea-water indicates a complexed form (probably organic) for these elements (Rona *et al.*[4]). In analyzing sea-water for iron (Laevastu and Thompson[5]) and copper (Alexander and Corcoran;[6] Slowey *et al.*[7]) higher concentration of these elements were observed in the dissolved state when the water was oxidized than when determinations were carried out without the oxidation step. Hood[8] stated that it has not been clearly demonstrated in any of the investigations that the inorganic elements in sea-water are chelated with organic compounds.

ZoBell[9] defined the dissolved organic matter as that which is not removed with a high speed centrifuge. Fox *et al.*,[10] Jeffrey and Hood[11] and Hayer *et al.*,[12] have reported the soluble organic matter as the one which passes through a 0·45-μ Millipore membrane filter. Duursma[13] attributed the following properties to the dissolved organic matter:

1. Not precipitable at pH 1 within 24 hours in a half-litre bottle,
2. Not retained by a membrane filter,
3. Not readily separated by centrifugation, and
4. Not co-precipitable with $Al(OH)_3$.

Of the various experimental definitions, the simplest, of course, is the one that uses the property of filterability of the olute in the medium. The 0·45-μ Millipore membrane filter has been widely used to separate dissolved substances and in this laboratory, as a lower limit, 0·22-μ membrane filters have been used for filtration throughout this work.

SOLUBILIZATION

It has not been possible, in the present experiments, to establish the chemical states of the trace elements dissolved in the medium; therefore, the rather loose term 'solubilization' was used to mean the process of keeping the elements in a state of dispersion or solution such that they passed through a 0·22-μ Millipore membrane filter.

The following laboratory experiments were conducted to provide direct evidence of the role of dissolved organic matter in solubilizing and complexing trace metallic ions. As representatives of di-, tri-, and tetravalent elements, manganous manganese, zinc, ferric iron and zirconium-niobium were chosen for the preliminary experiments.

MATERIALS AND METHODS

Culture.—An algal culture (*Microcystis littoralis,* a common littoral Cyanophyceæ from west coast of India) was grown in sea-water (collected from near-shore regions of Bombay, India) for six months and allowed to decay in dark for two years at constant pH(8·2), at ambient temperature (27° to 29° C.), and with constant concentration of major inorganic constituents. The supernatant liquid was then filtered. This culture filtrate and a sample of near-shore filtered sea-water were used for the investigations.

Dissolved Organic Matter.—Dissolved organic constituents in the filtered sea-water (20 1) and the culture filtrate (2 1) were concentrated on $Fe(OH)_3$ by the addition of $FeCl_3$ (5 mg./ml. of sea-water and culture filtrate) to the acidified medium followed by dropwise addition of ammonia while stirring. Stirring of the ammoniacal slurry was continued for 5 hours, $Fe(OH)_3$ was allowed to settle overnight, and the supernatant liquid was siphoned off; the $Fe(OH)_3$ was centrifuged, dispersed once in distilled water, recentrifuged, the supernatant liquid was discarded, the precipitate was dissolved in concentrated HCl, and the molarity was adjusted to 8. Iron was removed by repeated extractions with isopropyl ether equilibrated with 8 M HCl. During the process, 13% of organic matter was removed by the ether. The aqueous layer was then passed through an anion exchange column (20 cm. × 1 cm.) of Dowex 1– × 8 (50–100 mesh, conditioned with 8 M HCl) to remove last traces of iron, and the column subsequently was washed with two column volumes of 8 M HCl. The effluent and washings were concentrated to 5 ml. by evaporation under partial vacuum. The amino-acids in these concentrates were identified by descending paper chromatography using an *n*-butanol : acetic acid : water (4 : 1 : 4) solvent system. Amino-acids detected, by the comparison of R_f values of the ninhydrin reactive spots of the culture and sea-water with those of standard amino-acids, were cystine, lysine, arginine, serine, glycine, proline, glutamic acid, threonine, phenylalanine, tyrosine, methionine, valine, isoleucine, leucine and an unidentified amino-acid with a higher R_f (0·84) than that of Leucine (0·73). It may be noted that under the condition of low pH adopted in the procedure, the peptides or polypeptides that may be present in the media could have hydrolysed. The amino-acids identified in the chromatogram are all not necessarily present in the monomeric state. Since $Fe(OH)_3$ does not quantitatively remove the organic matter (*see also* Jeffrey and Hood;[11] Koshy[15]) no attempt was made to estimate the relative abundances of the different amino-acids in the two media. From the similarity of the nature of the amino-acids present in the culture filtrate and in sea-water, we have assumed that the nature of the organic matter present in the culture filtrate resembles those usually present in sea-water. The culture filtrate as well as the sea-water also gave an indication of the presence of the organic compounds of the quinonoid and phenolic character.

The carbohydrate content of the filtered sea-water and the culture filtrate was determined by use of anthrone reagent in H_2SO_4 (Lewis and Rakestraw[14]). Sea-water and culture filtrates were found to contain 0·3 mg./l. and 1·77 mg./l. of carbohydrates, respectively. Carbohydrates were not analysed for the individual components.

The dissolved organic matter of the culture that passed through the 0·22-μ Millipore membrane filter was caused to interact with added tracers such as Mn^{54} as $MnCl_2$, Zn^{65} as $ZnCl_2$, Fe^{59} as $FeCl_3$ and Zr^{95}-Nb^{95} as $ZrO(NO_3)_2$.

EXPERIMENTAL

Experiments with each element were conducted with 10 ml. of filtered sea-water and 10 ml. of culture filtrate. In each case, 100 λ of the tracer activity was added while pH was maintained at 8 by stirring with a glass rod previously dipped in dilute alkali. Solutions were stored for a week at room temperature (25° C.) with intermittent shaking, and then filtered again. Aliquots of the filtrates (5 ml.) were counted. As a blank, 100 λ of each respective tracer was dissolved in 5 ml. of distilled water. Since $MnCl_2$ was highly soluble in sea-water and in the culture filtrate, the effect of organic matter on solubilization of manganese was studied with the use of the insoluble manganese compound—$Mn(OH)_2$. Equal volumes of manganese chloride solution labelled with Mn^{54} were placed in two tubes and the hydroxide was precipitated by dilute ammonia, the solution was centrifuged, the supernatant rejected, and the precipitate repeatedly washed with doubly distilled water (DDW) until free of alkali. Equal volumes

(10 ml.) of filtered sea-water and culture filtrate were added to the precipitates, the solutions were stored for a week as above and filtered. Counting was conducted on 5 ml. aliquots of this filtrate. An equivalent amount of manganese, precipitated as hydroxide and washed free of alkali, was dissolved in 5 ml. of dilute HCl and counted to estimate the added activity. The specific activities and the results obtained are shown in Table I.

TABLE I

Solubilization of Mn, Zn, Fe^{3+} and Zr-Nb in sea-water in presence of dissolved organic matter

	Mn^{54}	Zn^{65}	Fe^{59}	*Zr^{95}–Nb^{95}
Specific activity in the system (counts per 5 min. per μg.)	15·85	1064	44370	678100
	Activity in counts per 5 minutes of			
	Mn^{54}	Zn^{65}	Fe^{59}	Zr^{95}–Nb^{95}
Total in the system ..	7928	4042	4526	6433
Solubilized in 10 ml. sea-water ..	26 (0·3%)	2866 (70·9%)	158 (3·5%)	1846 (28·7%)
Solubilized in 10 ml. culture filtrate ..	916 (11·6%)	4132 (100%)	2126 (47%)	5300 (82·4%)

Figures in parentheses indicate the percentage of the added activity. *Values of Zr concentration in sea-water are from Sarma *et al.* (1968).[21]

TABLE II

Behaviour of Mn, Zn, Fe^{3+} and Zr-Nb on Dowex 50W-× 8 cation column in presence of dissolved organic matter in sea-water

	Activity in counts per 5 min.							
	Mn^{54}		Zn^{65}		Fe^{59}		Zr^{95}–Nb^{95}	
	*S.W.	Culture	S.W.	Culture	S.W.	Culture	S.W.	Culture
Influent ..	10	366	1146	1653	55	744	738	2120
Effluent and washings ..	Nil	Nil	Nil	Nil	Nil	259 (34·8%)	306 (41·4%)	1815 (85·6%)

Figures in parentheses indicate the percentage of the influent activity. *Mn^{54} Cl_2 in sea-water was also observed to be completely cationic.

To investigate the state of the tracer activity in the sea-water and in the culture solution, 4 ml. aliquots (3·5 ml. for Fe^{59}) of each filtrate was passed through Dowex 50 W- × 8 (50–100 mesh) cationic exchange columns (5 cm. × 1 cm.) conditioned to the Na^+ form by neutral 3·5% NaCl. Each column was washed with 6 ml. of 3·5% NaCl, and the total effluent (10 ml.) from each concentrated to 5 ml. and counted. The activity recovered in the effluents is shown in Table II. The quantity of cationic resin taken was in overwhelming excess in its exchange capacity compared to the equivalents of the bi-, tri-, and tetravalent ions present in the influent.

RESULTS

Sea-water did not significantly solubilize Mn from $Mn(OH)_2$, whereas 11·6% of the Mn which was solubilized in presence of dissolved organic matter was in the cationic form (Tables I and II). About 29% of the zinc plated or precipitated out in sea-water at pH 8, but in the presence of dissolved organic matter all of the added zinc remained in solution or apparent solution. However, the solubilized zinc, in sea-water as well as in culture solution, was all in the cationic form as is evident from the cation exchange column experiment (Table II). While 96·5% of the added iron precipitated from sea-water, that solubilized (3·5%) was in the cationic form (Table II). Dissolved organic matter solubilized added iron to the extent of 47% of which at least 35% (corresponding to 16% of that added) was in the 'non-ionic' or 'anionic' complex form. Zirconium-niobium precipitated to the extent of about 71% at pH 8, whereas only 18% precipitated in the presence of dissolved organic matter. This indicates that at least 53% of zirconium-niobium was solubilized by the organic matter of the culture filtrate. Of the 29% of zirconium-niobium in sea-water, 41% passed through the cationic column (corresponding to complexing of about 12% of initial); of the 82% solubilized in the presence of dissolved organic matter in the culture filtrate, 85% passed through the cationic column (corresponding to complexing of about 70% of initial charge). This indicates the formation of very stable 'non-ionic' or 'anionic' complexes of zirconium-niobium.

The molar concentrations, readily calculated from the specific activity values, of the trace elements in solubilized state in sea-water and in the culture filtrate are about, 3×10^{-6} M and 1×10^{-4} M for Mn; 4×10^{-6} M and $5 \cdot 8 \times 10^{-6}$ M for Zn; $6 \cdot 4 \times 10^{-9}$ M and $8 \cdot 6 \times 10^{-8}$ M for Fe; and 3×10^{-9} M and $8 \cdot 5 \times 10^{-9}$ M for Zr-Nb, respectively. Sillen[1] noted that organic complexes contribute to some of the elements present at the very low concentration of 10^{-6} M to 10^{-7} M and it is striking that the concentrations of elements solubilized by the dissolved organic constituents have been observed to lie generally in the range of 10^{-6} M to two orders of magnitude below that speculated by Sillen (1961).

In a similar series of experiments, the authors (Desai *et al.*[15]) reported solubilization of *in situ* precipitated $BaSO_4$, as well as precipitated $BaSO_4$, in sea-water in the presence of dissolved organic matter. The average values obtained were 168 μg. Ba/l. in sea-water and 621 μg. Ba/l. in the presence of dissolved organic matter for *in situ* precipitated $BaSO_4$. Solubility of precipitated $BaSO_4$ was 132 μg. Ba/l. in sea-water and 497 μg. Ba/l. in presence of dissolved organic matter. Solubilized Ba was quantitatively retained on a sodium exchanged Dowex 50 W-$\times$ 8 (50–100 mesh) cation exchange column (5 cm. × 1 cm.). Similar behaviour was observed with solubilized $BaSO_4$ in dilute ammoniacal EDTA. Reported values for the concentration of Ba in sea-water cluster around 30-50 μg. Ba/l. (Krauskopf;[16] Chow and Goldberg;[17] Turekian and Johnson;[18] while Burton *et al.*[19] obtained a saturation value of 48 μg. Ba/l. (81 μg. $BaSO_4$/l).

Although the total organic content in the culture solution was comparable to that in some of the sea-waters, it is not yet clear as to what extent the above data can be quantitatively applied in the marine environment. The solubilization of all the ions observed in sea-water used in the experiment may also be caused, in part at least, by the dissolved organic matter already present in the system. However, in these demonstration experiments this point was not investigated further. Further work is in progress.

No attempts have been made to study the stability constants of the solubilized material since it has not been possible to establish the individual concentrations of the dissolved organic constituents of the culture filtrate.

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FORMATION OF THE *CHAKARA* (MUD BANK) ON THE KERALA COAST

P. UDAYA VARMA AND P. G. KURUP
Physical Oceanography Division, National Institute of Oceanography, Cochin

INTRODUCTION

THE appearance of *Chakara* along the coastal waters of Kerala is a peculiar phenomenon occurring prior to or during the South-West Monsoon. This phenomenon has been noticed from time immemorial. The first mention of the *Chakara* in recorded history can be seen as early as 1755, when Captain Cope described the Alleppy *Chakara* in his *A New History of the East Indies.* The two volumes published by Bristo (1938) contain references to the mud bank by early authors. These are mostly qualitative descriptions of the characteristics of the mud banks.

The formation of *Chakara* is restricted to a section of 270 kilometers of the Kerala coast between Calicut and Quilon at definite locations. During *Chakara* the bottom mud is kept in suspension thus making the water highly turbid and viscous. This leads to the viscous damping of the waves on the offshore side of the *Chakara* thereby making the lee side water calm. The mud banks extend in a semicircular shape towards the sea. The seaward extension of the banks is usually the six-fathom line at a distance of about 3½ miles from the shore. The along-shore stretch varies between 2–3 miles. The depth contours broaden out seaward in the mud bank regions.

EARLIER THEORIES OF FORMATION

Various theories have been put forward to explain the *Chakara* formation. The first one was by John Rhode (1886) (*see* Bristow, 1938). He stated that the mud bank at Alleppy was formed by an underground discharge of mud by the hydraulic pressure head developed in the backwaters due to increase in water level during monsoon. Du Cane *et al.* (1938) have suggested that *Chakara* formation is due to the stirring up of the already existing bottom mud in the near-shore region by the action of high waves, generated by the pre-monsoon winds. They also emphasized the role of rivers in the supply of sediments, as most of the mud banks are found near river mouths. The lowering of salinity helps to keep the sediments in suspension for longer period. A third theory was put forward by Ramasastry and Myrland (1959). According to them the formation of mud banks is due to upwelling near the bottom, between 20–30 m. along the coast line which produce vertical accelerations with resultant lifting of bottom waters. The lifted bottom water carries along with it the fine bottom mud.

Since the maximum possible rise in water level in the backwaters is only five feet, the pressure developed due to this is insufficient to cause a subterranean mud flow (Bristow, 1938). Coggin Brown's analyses of the bore samples from Alleppy, Wellington Island and Cochin revealed that the character of the deposits is sufficient to rule out the possibility of subterranean channel flow. Even though upwelling can lift up bottom sediments as occurs in the Benguela upwelling region (Hart and Curie, 1960), it is doubtful whether an overturning of subsurface water as occurs along this coast can bring up large quantity of mud from the bottom and keep it in suspension for a sufficiently long period.

The theory of Du Cane *et al.* partly explains the role of waves in the formation of *Chakara.* However, it fails to explain their formation at definite locations along the coast.

PRESENT OBSERVATIONS AND INFERENCES

The recent observations by the authors and other published works reveal the possible physical forces responsible for the formation of *Chakara.* During the cyclone of December 1965, large quantity of mud was dumped on the beach north of Cochin entrance to a distance of about three miles (Varadachari and Murthy, 1966). By July 1966 all the mud was carried offshore by waves and *Chakara* was observed during July.

A *Chakara* was formed at Punnappura in 1966 even before the onset of S-W monsoon. In 1968 two mud banks were found, one offshore at Nircunnam and another at Nattika, about 40 miles north of Cochin where there is no freshwater discharge from river. In 1969 prior to the onset of the S-W monsoon a mud bank has appeared 2 miles south of the Nircunnam point. It has been observed that before the formation of this *Chakara* there were persistent ground swells of 12-14 seconds period from south-west. In 1968, before the formation of *Chakara,* the wave approach at Nircunnam and Nattika was parallel to the coast. At Nircunnam the littoral current was found to be converging from either side of the mud bank.

From these observations it can be deduced that freshwater discharge from rivers has not been of much significance in the formation of *Chakara,* since they have appeared prior to the active monsoon and also at places where there is no discharge of freshwater from rivers. At the same time, the importance of wave action can be assessed, because these mud bank formations have been preceded by persistent action of high period waves.

The wave refraction studies carried out for Nircunnam region, using bathemetric charts corrected upto 1962, reveal the possibility of formation of rip currents in this region for higher period waves, which can carry finer sediments offshore and prevent onshore transport of sediments by waves. Thus localisation of finer sediments can take place at the rip head which, when settled, will extend the bottom contours offshore. This feature has been revealed by a small survey conducted by the authors off Nircunnam.

The dumping of large quantities of mud on the Elankunnapuzha beach north of Cochin, during December 1965 cyclone, shows the possibility of localised onshore transport of offshore bottom mud by mere wave action. Such onshore transport of bed-load by wave action might be taking place in other regions also and where this is opposed by rip currents *Chakara* formation takes place.

During South-West monsoon the surface salinity decreases considerably. Very near the shore the surface salinity falls to about 27‰ (Damodaran and Hridayanathan, 1966). The rip currents carry this low salinity water offshore, thereby diluting the offshore waters, which facilitates the deflocculation of sediments in suspension, which accounts for continued existence of the *Chakara.* As the salinity increases during the post-monsoon season the mud flocculates and settles down, and the *Chakara* disappears.

Such phenomenon may be taking place in other regions also where *Chakara* have been observed. Studies are being made to establish the existence of rip currents in other *Chakara* regions.

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LETTERS TO THE EDITOR

AN INVARIANT OF THE SPHERICALLY SYMMETRIC SOLUTIONS OF $R_{ij} = 0$

For spherically symmetric metrics of the form

$$ds^2 = -\,\mathrm{A}dr^2 - \mathrm{B}d\Omega^2 + \mathrm{C}dt^2 + 2\mathrm{D}\,drdt \tag{1}$$

where

$$d\Omega^2 \equiv d\theta^2 + \sin^2\theta d\phi^2,\ \mathrm{B} > 0,\ \mathrm{M} \equiv \mathrm{AC} + \mathrm{D}^2 > 0,$$

and A, B, C, D are functions of r and t, the only non-vanishing independent components of R_{ij} and R_{hijk} are connected by[1a],

$$\left.\begin{aligned} R_{11} &= \frac{2f_1}{\mathrm{B}} - \frac{\mathrm{A}f_2}{\mathrm{M}}, \\ R_{14} = R_{41} &= \frac{\mathrm{D}f_2}{\mathrm{M}} - \frac{2f_5}{\mathrm{B}}, \\ R_{22} = \frac{R_{33}}{\sin^2\theta} &= \frac{(\mathrm{C}f_1 + 2\mathrm{D}f_5 - \mathrm{A}f_4)}{\mathrm{M}} + \frac{f_3}{\mathrm{B}}, \\ R_{44} &= \frac{\mathrm{C}f_2}{\mathrm{M}} + \frac{2f_4}{\mathrm{B}}, \end{aligned}\right\} \tag{2}$$

where

$$f_1 = R_{1212} = \frac{R_{1313}}{\sin^2\theta},\ f_2 = R_{1414},\ f_3 = \frac{R_{2323}}{\sin^2\theta},$$

$$f_4 = R_{2424} = \frac{R_{\ 434}}{\sin^2\theta},\ f_5 = R_{1224} = \frac{R_{1334}}{\sin^2\theta}.$$

If $R_{ij} = o$, it follows from (2) that

$$\frac{2f_1}{\mathrm{A}} = \frac{\mathrm{B}f_2}{\mathrm{M}} = \frac{-f_3}{\mathrm{B}} = \frac{-2f_4}{\mathrm{C}} = \frac{2f_5}{\mathrm{D}} = \mathrm{I} \tag{3}$$

where I must be an invariant because f_3/B is an invariant for transformations preserving the form (1). If I is zero, no f can be non-zero and the space-time is flat. Also if A, B, C, D are non-zero and any one f vanishes, then all other f's must vanish implying a flat space-time.

For a non-flat solution of $R_{ij} = 0$, since $\mathrm{B} > 0$ and $\mathrm{M} > 0$, we must have $f_2 \neq 0$ and $f_3 \neq 0$; and hence if any one of A, C or D is zero, then accordingly f_1, f_4 or f_5 must vanish.

We can have the following five types of solutions of $R_{ij} = 0$, each of which is a transform of the Schwarzschild solution.

(*i*) *Finkelstein's*[2] solution (A, B, C, D non-zero):

$$ds^2 = -\left(1 + \frac{2m}{r}\right)dr^2 - r^2d\Omega^2 + \left(1 - \frac{2m}{r}\right)dt^2 + \frac{4m}{r}drdt:$$

(*ii*) (A = 0):

$$ds^2 = -\,r^2d\Omega^2 + \left(1 - \frac{2m}{r}\right)dt^2 + 2drdt:$$

(*iii*) *Isrœl's*[3] *solution* (C = 0):

$$ds^2 = \frac{-t^2dr^2}{2m}\left(2m + \frac{rt}{4m}\right)^1 - \left(2m + \frac{rt}{4m}\right)^2 d\Omega^2 - 2drdt:$$

(*iv*) *Takeno's*[1b] *solution* (A = 0, C = 0):

$$ds^2 = -\,y^2d\Omega^2 - 4p^2\left(1 - \frac{2m}{y}\right)drdt:$$

where

$y = y\,(u)$, $u \equiv r + t$ is given by
$y + 2m \log\,[p\,(y - 2m)] = c - pu,$

c, p being arbitrary constants;

(*v*) *Schwarzschild's solution* (D = 0):

$$ds^2 = -\left(1 - \frac{2m}{r}\right)^{-1}dr^2 - r^2d\Omega^2 + \left(1 - \frac{2m}{r}\right)dt^2.$$

In all these cases, we find that the invariant I is given by

$$\mathrm{I} = \frac{2m}{\sqrt{\mathrm{B}}},\quad m \text{ a constant.} \tag{4}$$

Like the Schwarzschild solution there are other solutions involving moving mass singularities for which $R_{ij} = 0$. For a spherically symmetric situation involving many mass singularities in motion,

$$\mathrm{I} = \frac{-f_3}{\mathrm{B}} = 1 - \frac{\mathrm{CB}'^2 - 2\mathrm{DB}'\dot{\mathrm{B}} - \mathrm{A}\dot{\mathrm{B}}^2}{4\mathrm{MB}}. \tag{5}$$

We have (4) for an isolated singularity as a particular case of (5). (4) is also applicable to the geodesic form[4] of the line-element for an isolated mass, *viz.*,

$$ds^2 = dt^2 - \left(1 \pm \frac{3\sqrt{2m}\,t}{2r^{3/2}}\right)^{-2/3}dr^2 - r^2\left(1 \pm \frac{3\sqrt{2m}\,t}{2r^{3/2}}\right)^{4/3}d\Omega^2.$$

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EFFECTIVE ATOMIC NUMBER FOR DIFFERENTIAL K-SHELL PHOTOELECTRIC EFFECT IN Pt-Rh ALLOY

Hine[1] pointed out that the effective atomic number for partial gamma-ray interactions cannot be represented by a unique number and the number for each partial process has to be computed separately. In a previous investigation[2] Hine's predictions for total atomic photoelectric effect has been verified and showed that the number can be defined uniquely down to the gamma energy where occurs the K-edge of the highest atomic number element involved in each alloy. The present investigations deal with a study of the uniqueness of the number for differential K-shell effect in a typical alloy, Pt-Rh (Pt, 80% ; Rh, 20%) at three gamma energies 100, 145 and 280 keV above K-edge energy of Pt where the number for total effect can be defined uniquely. This can be studied by comparing the differential K-shell photoelectric cross-sections in the alloy with those in the element of equivalent atomic number.

In view of the general agreement of the differential K-shell photoelectric cross-sections of Nagel[3] with that of the experiment[4,5] within the limits of experimental errors and difficulties the differential K-shell photoelectric cross-sections in Pt-Rh alloy are estimated from the theoretical differential cross-sections based on Nagel's expressions in Pt and Rh at three gamma energies 100, 145 and 280 keV. The effective atomic number for Pt-Rh alloy is found to be 72 ± 1. So the obtained angular distributions in the alloy are compared with those in Ta whose atomic number is 73. However, in actual comparison the differential cross-sections in Ta are normalised to that of the alloy. The comparison of the differential cross-sections are shown in Fig. 1.

It can be seen from the figure that the two distributions differ[1] in angle of maximum cross-section,[2] in maximum cross-section and[3] in spread. However, the differences become more and more as the energy decreases. Thus it can be concluded that, as far as total effect is concerned even though the alloy behaves like the element of respective effective atomic number, it differs in respect of differential effect. Hence, the effective atomic number for differential photoelectric effect cannot be defined uniquely, especially at lower and lower gamma energies, except at the angles where the two distributions intersect each other.

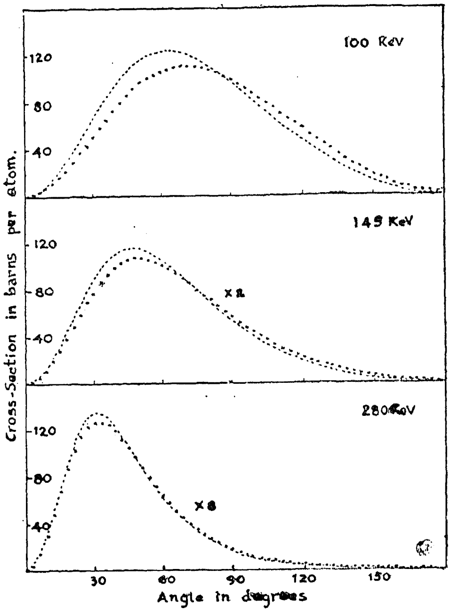

FIG. 1. Differential cross-sections. X-axis: angle in degrees; Y-axis: cross-section in barns per atom; — — — — cross-section in equivalent atomic number element as in alloy; × × × × × cross-section in alloy (Pt-Rh).

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ANNEALING OF CHEMICAL RADIATION DAMAGE IN POTASSIUM CHLORATE

ALTHOUGH some considerable work has been done on the identity and the yield of the various fragments generated in crystalline chlorates by high energy radiations so far only two reports have appeared on the dependence of the yields on heat treatment. Baberkin[1] found that the 100 ev yield of chlorite in cobalt-60 γ-irradiated potassium chlorate decreased from 1·2 to 0·8 molecules on heating the material at 200° C. The decrease in the yield of chlorite was attributed to its decomposition into chloride and oxygen. Patrick and McCallum[2] repored that whereas the yield of chloride in γ-irradiated sodium chlorate reached a maximum and then decreased to a stationary value on heating at 50° C., at higher temperatures the yield increased progressively. It was considered that the increase in the chloride yield was due to thermal decomposition and the later decrease due to recombination of chloride and oxygen. We have now observed annealing in γ-irradiated potassium chlorate when heated.

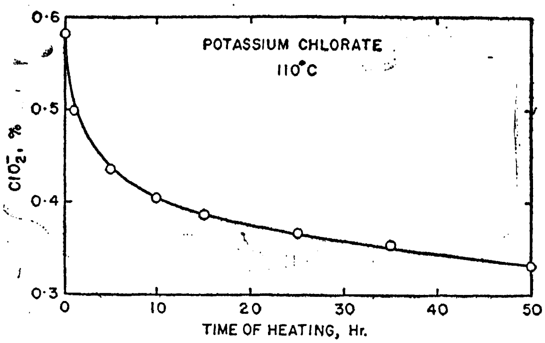

Fig. 1. Annealing of chlorite in gamma-irradiated potassium chlorate at 110° C.

Reagent grade potassium chlorate was recrystallized several times from hot aqueous solution. The crystals were thoroughly dried, first at 110° C. for 25 hours and subsequently in a vacuum desiccator over phosphorus pentoxide, and irradiated in sealed glass ampoules at room temperature with 50 Mrad of cobalt-60 γ-rays at a dose rate of 0·83 Mrad hr^{-1}. The damage Cl^-, ClO^-, and ClO_2^- ions in the irradiated crystals were determined by potentiometric microtitrations, the Cl^- ion in 0·01 M borax solution against standard silver nitrate, and ClO^- and ClO_2^- in 0·3 M sodium bicarbonate solution against arsenious acid with osmium tetroxide added as a catalyst after the ClO^- equivalence.[3] A typical set of results for the disappearance of ClO_2^- upon thermally annealing irradiated potassium chlorate is shown in Fig. 1; the fraction of the initial chlorite recovered in 50 hours heating at 110° C. was 0·429.

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Nuclear Chemistry Laboratory, S. R. MOHANTY.
Department of Chemistry, V. M. PANDEY.
Utkal University,
Bhubaneswar-4, *August* 18, 1969.

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THERMODYNAMICS OF COPPER (II) CHELATES OF 8-QUINOLINOL DERIVATIVES

COPPER chelates of 8-hydroxy quinoline-7-sulfonic acid (RI), 5-chloro-8-hydroxy quinoline-7-sulfonic acid (RII), 5-bromo-8-hydroxy quinoline-7-sulfonic acid (RIII) and 5-iodo-8-hydroxy quinoline-7-sulfonic acid (RIV) have been studied to determine the composition, stability constant and thermodynamic properties like $\triangle F°$, $\triangle H$, $\triangle S$ associated with the formation of the complex, by spectrophotometric method in aqueous medium.

The spectral absorbance measurements were made on a Hilger-Uvespec Spectrophotometer (Model H 700–308), equipped with thermoplates to stabilize the temperature of the cell holder. The preparation of the reagent solutions and the experimental details are similar to those described in our previous publications.[1,2]

The composition of the complexes were established by three independent methods spectrophotometrically as the continuous variation method of Job,[3] the mole-ratio method of Yoe and Jones[4] and the slope-ratio method of Harvey and Manning.[5] The results indicate that one mole of copper combines with two moles of the chelating agent to form a stable complex in solution.

The stability constant of the complexes were calculated by the method of Banerji and Dey[6] and the mole-ratio method.[4] The thermodynamic properties like $\triangle H$ and $\triangle S$ were calculated by temperature coefficient method and Gibbs-Helmholtz equation (Table I).

TABLE I

Complex	log K (30° C.)	$-\triangle F^0$ (k.cal./mole) (30° C.)	$-\triangle H^0$ (k.cal./mole)	$\triangle S$ (e.u.)
Cu $(RI)_2$ ..	9·84	13·68	5·3	63·2
Cu $(RII)_2$ ..	9·26	13·84	3·66	52·9
Cu $(RIII)_2$ ..	9·45	13·13	4·1	56·76
Cu $(RIV)_2$ ..	9·64	13·40	4·57	59·3

The thermodynamic ionization constants of these sulfonic acids were determined by the method suggested by Philip[7] and are given in Table II.

TABLE II

Acid	pKa_1	pKa_2	$\triangle F^0_1$ (k.cal./mole)	$\triangle F^0_2$ (k.cal./mole)
RI ..	4·27	8·76	5·87	12
RII ..	3·87	8·46	5·31	11·59
RIII ..	4·08	8·56	5·67	11·74
RIV ..	4·17	8·66	5·71	11·86

The pKa values of these acids may be compared to the corresponding values of the parent compound 8-hydroxy quinoline obtained by Nasanen.[8] The sulfonic acid group is known to be a σ and π electron acceptor. The lower pKa values of the sulfonate derivative may be considered as the result of electronic interaction of the sulfonate group with the aromatic ring. Although the sulfonic acid group itself is negative, the nature of the interaction is such that negative charge is withdrawn from the ring. The acid dissociation constants of the halo-substituted acids are lower owing to the inductive electron withdrawing effect of halogen. The order of the effect is Cl > Br > I.

A close relationship between the ligand basicity and the complex stability (overall formation constant log K) is well expected. From Tables I and II, it is observed that a rough linear relationship between pKa and log K is obtained. A similar relationship is also obtained in the case of entropy and enthalpy changes of the complexes with the ionization constants of the ligands.

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Chemical Laboratories,
Birla Institute of
Technology and Science,
Pilani, Rajasthan (India),
August 20, 1969.

K. BALACHANDRAN.
SAMIR K. BANERJI.

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ELECTRON SPIN RESONANCE OF Cu^{++} IN K_2SO_4 SINGLE CRYSTALS

SINGLE crystals of K_2SO_4 doped with Cu^{++} are grown from aqueous solution of potassium sulphate mixed with copper sulphate, and electron spin resonance (ESR) spectra are obtained with an X-band spectrometer at liquid nitrogen temperature. Orthorhombic K_2SO_4 has 4 molecules per unit cell and has been investigated earlier in this laboratory to identify the radiation-induced defects.[1,2] Since copper consists of two isotopes each possessing spin 3/2 with nearly equal magnetic moments, they give nearly equal hyperfine structures which can only be separated experimentally under the most favourable conditions. When separated like that, the intensity of the two lines would be in the ratio of their relative abundances 1 : 2·23.

Figure 1 shows the observed ESR spectra taken at 77° K. with the magnetic field

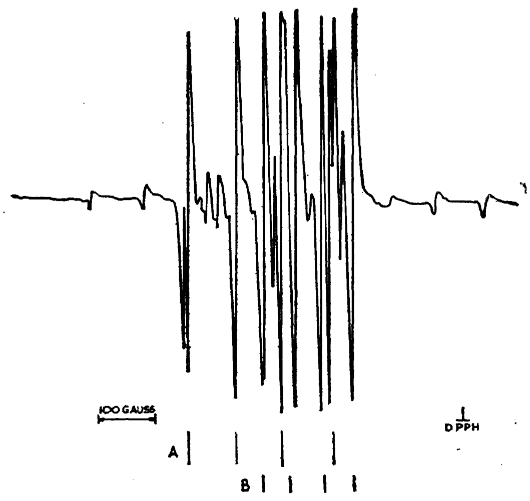

FIG. 1. ESR spectrum of Cu^{++} in K_2SO_4 single crystal at 77° K. The magnetic field is parallel to the [001] direction. A and B refer to the two magnetically inequivalent sites.

parallel to the [001] direction in the (010) plane. The angular variation of the main spectrum revealed that the Cu^{++} ion has two inequivalent sites. The two turning points in this plane correspond to a spectrum centred at $g = 2 \cdot 026$ and $g = 2 \cdot 384$ with the corresponding $\triangle H$ values as 72 and 92 Gauss respectively. However, along the [100] direction, the two inequivalent sites are equivalent and only a single set of four lines centred at $g = 2 \cdot 165$ with $\triangle H = 87G$ has been observed. An interesting result is that the lines corresponding to the two isotopes are separated with the expected intensity ratio of 1 : 2·23.

When divalent impurity cations are trapped at the site of the monovalent ions of the host lattice, the excess charge that results must be compensated by producing, for example, a cation vacancy. In certain cases, it can also go to an interstitial position, resulting in super-hyperfine interaction with the neighbouring nuclei as observed in the case of NH_4Cl[3] and NH_4Br.[4] No such super-hyperfine interaction was observed in the present case.

From crystal sructure data[2] it is clear that there are two types of potassium ions in the crystal with the (100) plane as a symmetry plane. The Cu^{++} when trapped at the site of the potassium ion would give rise to an ESR spectrum with orthorhombic symmetry having two inequivalent sites. Along the [100] direction, the two ions are equivalent and should give rise to a single set of four lines. The angular variation of the ESR spectrum has actually revealed all these observations. These results are comparable with the results on Mn^{++} doped K_2SO_4[5] and Cu^{++} and Mn^{++} doped Rb_2SO_4.[6]

Apart from this spectrum, the presence of a relatively weak spectrum is observed. The relatively low intensity suggests that there are fewer types of such ions in the lattice. A detailed analysis of this spectrum is in progress.

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Dept. of Physics,
Indian Institute of
Technology,
Madras-36,
September 3, 1969.

(Miss) Meera Chandrapal.
N. Hariharan.
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MODIFIED GALLEIN METHOD FOR THE DETERMINATION OF TIN IN SOILS AND ROCKS

Gallein was first described by Wood[1] as a reagent for the determination of tin (Sn^{+4}) in soils and rocks, after its isolation from tin bearing samples by volatalisation as SnI_4. The method consists in the formation of Sn^{+4}—Gallein complex in HCl solution buffered with monochloracetic acid and sodium-monochloracetate containing hydroxylamine hydrochloride which not only reduces Fe^{+3} but also discharges the colour of iodine formed during volatalisation. The optical density of the pink-red coloured complex is measured at 500 mμ. In a subsequent modification of this method by McDonald and Stanton[2] the complex was extracted into Pentyl alcohol before measuring the optical density. The most recent modification of this method was by Marranzino and Ward[3] of the USGS who extracted the Sn^{+4}—Gallein complex with a mixture of 2 ml. of cyclohexanone and O-dichloro benzene and made visual comparison of the coloured organic layer with standards.

Though the USGS procedure serves the purpose of a field method suitable for the geochemical exploration of tin, it is not sufficiently rapid besides having some inherent disadvantages. While adopting this method for the determination of tin in our Laboratory, we found it very slow and felt the need for further improvement so as to make it sufficiently rapid by avoiding some of the unnecessary steps suggested in the procedure. One of them is mixing the sublimate of SnI_4 with unattacked sample while leaching with HCl-alcohol mixture, thereby introducing Fe^{+3} into the test solution. This makes it imperative to reduce Fe^{+3} in the next step by heating with buffer solution containing hydroxylamine hydrochloride and subsequent cooling before complexing with gallein, thus considerably slowing down the procedure. Introduction of Fe^{+3} into the test solution and later taking steps to eliminate its interference in the reaction by reduction to Fe^{+2} is, in our opinion, unnecessary. The use of hydroxylamine hydrochloride can be dispensed with and iodine which accompanies SnI_4 during volatalization and goes into the test solution can be discharged with a few drops of dilute sodium thiosulphate in cold. Moreover, the organic layer of cyclohexanone and O-dichlorobenzene takes a long time to clear before a visual comparison of its colour can be made (about half-an-hour), thus making it very slow. O-dichlorobenzene, if replaced by benzene, the organic layer becomes clear in five minutes.

We, therefore, suggest the following modified procedure which makes it sufficiently rapid and convenient for adoption in the field:

Procedure.—Weigh 0·1 to 0·2 gm. of tin bearing sample into an ordinary test-tube. Mix the sample thoroughly with 0·5 gm. of ammonium iodide. Wrap the upper portion of the test-tube with a wet filter-paper. Heat slowly over a small flame till vapours of ammonium iodide and iodine cease to evolve. Continue heating at dull redness for, a few more minutes. Apply heat in such a way that SnI_4 sublimes at least 3 cm. above the bottom of the test-tube. While still hot, introduce a drop or two of water by a thread of glass rod on the hot surface below the sublimate and separate that portion of the test-tube by gentle tapping with a glass rod. Introduce the broken test-tube containing SnI_4 sublimate into a 100 ml. beaker. Wet the sublimate by slowly pouring down the walls of the test-tube 5 ml. of a mixture of 1 : 1 alcohol and 2 M HCl. Then transfer the same completely by using a jet of water. Make up to 50 ml. and allow to settle. Withdraw aliquots into stoppered measuring cylinders. Add 5 ml. of a buffer solution (10 gm. monochloracetic acid + 10 gm. sodium monochloracetate in 100 ml. distilled-water). Add dropwise dilute sodium thiosulphate solution till the colour of iodine is discharged. Make up to 9 ml. Add 1 ml. of 0·02% Gallein solution and mix. After keeping for a few minutes, extract with a mixture (3 ml.) of 1 : 2 benzene and cyclohexanone. The organic layer becomes clear in five minutes. Compare the colour with similarly prepared standards.

The tin content of the following samples determined by the USGS method and the method as modified by us are shown in Table I. There is absolute agreement between the two sets of values.

TABLE I

	Sample	USGS method of Marranzino and Ward	Gallein method modified by us
		(Tin in ppm.)	
Drill core sample from Wynad, Kerala	W 2	250	250
	W 3	62·5	62·5
Dyke rock sample from Chelima, Andhra Pradesh	D 2	12	12
Granite and Diabase of the U.S.G.S.	G 1	3	3
	W 1	3	3

We wish to express our thanks to Shri C. Karunakaran, Dr. A. N. Chowdhury and Shri C. R. Viswanadham, of the Geological Survey of India, for their kind encouragement and interest. We are grateful to Shri G. C. Chatterji, Director-General, Geological Survey of India, for permission to publish this paper.

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EFFECT OF ASCORBIC ACID ON ALKALINE PHOSPHATASE ACTIVITY

THE subcellular particles in the gastrocnemius, sartorius and pectoralis muscles of frog were found to possess charges and migrate to the respective poles on application of voltage gradient.[1-5] The major protein fraction possessed a net positive sign of the charge and migrated towards the cathode within the muscle.[6] Similarly, the enzymes such as succinate and lactate dehydrogenases possessed a net positive sign of the charge, while proteases and acetylcholinesterase, a net negative sign of the charge.[6] In the present investigation an attempt was made to study the charge pattern of alkaline phosphatase (EC 3.1.3.1), an enzyme concerned with the energy relations of the cell, and its activity in the presence of various concentrations of ascorbic acid and EDTA (Ethylene-diamine tetra-acetic acid) and cysteine in the gastrocnemius muscle of frog.

The frogs, *Rana hexadactyla*, were double pithed and the gastrocnemius muscle from both the legs were excised with least injury. They were washed in amphibian Ringer's medium[7] and kept for 20 minutes to recover from shock effects. The experimental muscle was exposed to a long axis voltage gradient of 6 V d.c./cm. for 20 minutes using platinum electrodes placed 1 cm. apart from the centre of the muscle. Soon after the completion of the exposure period, the muscle was cut transversely into two equal halves and chilled to 0° C. The muscle half that was in contact with the anode was called the anode half (AH) and the one with the cathode was called the cathode half (KH). Similarly, the normal muscle was cut into two halves. The anterior and posterior bits were called control 1 (C_1) and control 2 (C_2), respectively. Each muscle was homogenized in 0·25 M sucrose and the alkaline phosphatase enzyme was assayed following the procedure given in Oser.[8] The experimental tubes contained different concentrations of ascrobic acid and 0·1 M EDTA and cysteine.

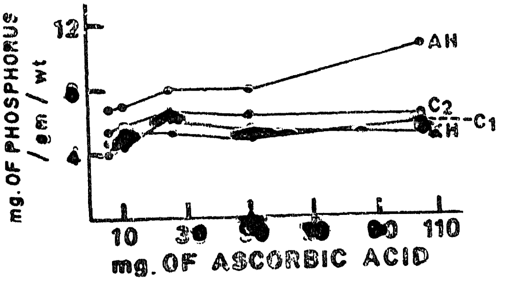

FIG. 1

The level of enzyme activity was similar in both the control halves (C_1 and C_2), suggesting a uniform distribution of the enzyme along the length of the muscle. The anode half (AH) had higher level of enzyme activity and the cathode half (KH) low level of enzyme activity when compared to the controls, suggesting the existence of a net negative sign of the charge on the enzyme as revealed by its migration towards the anode.

In general, the addition of ascorbic acid elevated the activity of the alkaline phosphatase in all the muscle halves. This accelerating effect was limited in the cathode half and controls at concentrations of ascorbic acid above 25 mg. indicating a sort of independence of the enzyme catalyzed reaction to the ascorbic acid content. The pattern of activation by this catalyst at concentrations above 25 mg. shows a resemblance to zero order type kinetics as compared to ascorbic acid. In the case of the anode half homogenate there seemed to be a continuous increase with the increase in ascorbic acid suggesting the dependence of enzyme catalyzed reaction to that of the first-order reaction of the enzyme kinetics as compared to ascorbic acid. It is likely that the basic protein in the anode half provides a congenial environment for the enzyme activity, presumably by exposing more of the active sites being catalyzed by ascorbic acid. The cathode half with the acidic protein and the controls with the mixture of acidic and basis protein are not as efficient as the anode half which contains major basic protein for inducing higher activation either individually or catalyzed by ascorbic acid.

EDTA and cysteine are potent inhibitors of alkaline phosphatase.[9-12] In the present study, the mechanism of inhibition by the two inhibitors seems to be different. It was about 50% inhibition in all the muscle halves with EDTA and about 70% with cysteine, suggesting that cysteine is a more potent inhibitor than EDTA for the alkaline phosphatase of the amphibian skeletal muscle.

TABLE I

Effect of EDTA and cysteine on alkaline phosphatase activity in the anode (AH), cathode (KH), control 1 (C_1) and control 2 (C_2) halves of the gastrocnemius muscle of frog. Activity is expressed as mg. of phosphorus/gm./wt. of tissue

Each value represents an average of eight individual experiments

	AH	KH	C_1	C_2
Normal	5·40 ± 0·51	3·80 ± 0·30	4·30 ± 0·56	4·5 ± 0·52
EDTA	2·70 ± 0·34	1·80 ± 0·19	1·70 ± 0·10	2·20 ± 0·19
Cysteine	1·80 ± 0·20	0·80 ± 0·19	1·25 ± 0·45	1·70 ± 0·16

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Dept. of Zoology, A. SUBBARAMI REDDI.
Sri Venkateswara Univ.,
Tirupati (A.P.), *August* 9, 1969.

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SOLUBLE ANTIGEN OF *T. EVANSI* IN BLOOD SERUM OF INFECTED ANIMALS

Trypanosoma evansi is a hæmoprotozoa affecting many animal species like cattle, buffalo, horse, dog and mouse. The disease caused by *T. evansi* is commonly called *Surra* in Hindi and is naturally transmitted by arthropod vectors. Several methods are reported for demonstrating the antigen-antibody reactions in trypanosomiasis.[2,8,9] Soluble protozoal antigens in the blood serum of the affected host have been demonstrated in experimental babesiosis[7] and in African trypanosomiasis.[3,6]

This preliminary report is on the serologic evidence of a trypanosome-soluble antigen in the blood serum of camel and buffalo suffering from the natural infection (*Surra*).

The trypanosomes were collected from acutely affected animal as described by Gill,[1] and homogenate prepared according to Seed.[5] Rabbits were immunized by injecting 4 ml. dose of the above homogenate by subcutaneous route at 4–5-day interval on five occasions. Bleeding of the rabbits was done by cardiac puncture. Hyperimmune serum was preserved at 4° C. after adding sodium azide in the final dilution of 1 : 1000.

The sera of *Surra*-affected animals was also collected aseptically and preserved at 4° C. by adding sodium azide as above. The procedure of Pande and Pathak[4] was used in the gel diffusion test.

The reaction, between the sera of the naturally infected camel or buffalo showing parasætemia and antitrypanosome rabbit serum, in gel was usually marked by formation of precipitin band (Fig. 1). No precipitin line was observed between the sera of these affected animals and the normal rabbit serum.

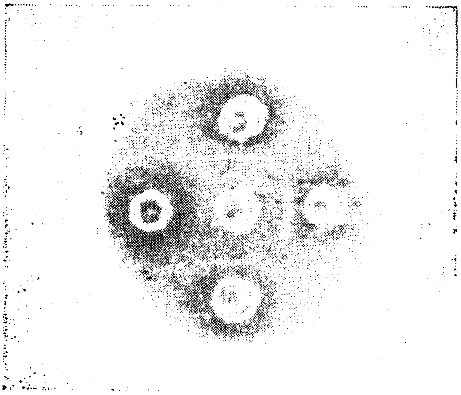

FIG. 1. Showing bands of precipitin in gel. The central cup contains the anti-trypanosome hyperimmune serum and peripheral cups sera from camel and buffalo affected with trypanosomiasis (*Surra*).

During the course of these studies with gel reactions, precipitin bands were also observed occasionally in between the cups containing sera samples from different trypanosome-affected or carrier animals. Such reactions indicate the presence of a diffusible trypanosome precipitinogen and specific precipitin antibody in the blood of animals having trypanosomiasis (*Surra*) of a varying duration.

Similar soluble antigen has been reported in equinebabesiosis.[5,7] The earlier workers studying *Babesia* infections have suggested that production of the antigen in detectable quantities is dependent on a certain stage of the growth and developmental cycle of the parasite.[5] Sibinovic *et al.*[7] have further speculated the similarity between the soluble antigens of *Babesia* and some African trypanosomes and that they also possess the ability to stimulate production of immune antibody in infected animals. The role of such soluble antigens (in protozoan infection) in the pathogenesis of the disease *vis-a-vis* host-parasite relationship is not clear at the moment and needs further investigation.

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U.P. College of Vet. Sci. S. R. BANSAL.
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A LABORATORY TECHNIQUE FOR MASS REARING OF THE TOBACCO CATERPILLAR *SPODOPTERA LITTORALIS* (BOISD.) *PRODENIA LITTURA* (F.) (NOCTUIDAE : LEPIDOPTERA) ON SYNTHETIC DIET

ARTIFICIAL diets for a number of Lepidopteran insects have been developed by various workers.[1] An attempt was made to develop a synthetic diet for *Spodoptera littoralis* (Boisd.) that will facilitate rearing of this insect all through the year in the laboratory.

The composition and various ingredients used for preparing the diet are given below:

Soaked peas (*Pisum sativum* L.) 50 g.; Yeast tablet (Alembic) 2 g.; Agar 300 mg.; Ascorbic acid 500 mg.; Calcium pantothenate 150 mg.; Nicotinic acid 100 mg.; Folic acid 50 mg.; Pyridoxin HCl 50 mg.; β-Sitosterol (Sigma grade) 50 mg.; Methyl paraben (Sigma grade) 50 mg.; Formalin 40% 10 drops; Water 80 ml.

To prepare the diet, agar was placed in a beaker containing 50 ml. of water and boiled to dissolve the agar. The soaked seeds, after removal of the seedcoat, were weighed and put into a glass homogenizer and blended in 30 ml. of water with other ingredients. The agar solution was poured into the food mixture with constant stirring. A small quantity of this semi-solid food was poured into a test-tube of $7\frac{1}{2} \times 2\frac{1}{2}$ cm. which has been previously sterilized by heating in an air oven, and set aside to cool under the fan.

Freshly hatched larvæ obtained from a single egg mass were introduced into each tube at the rate of 10 per tube and the tubes were plugged with sterile cotton plugs. Three or more tubes were held together and kept inverted for the first few days as described by Nachiappan.[2] At the end of the 5th day, the larvæ were separated and kept at the rate of two per tube. They were subsequently separated on the 10th day and kept individually in each tube, till they pupated. During these growing periods the tubes were kept horizontally. Fresh food was supplemented once in five days at the time of separating the larvæ as the food had been eaten by them.

The control larvæ were maintained on castor leaf in small jars as described by Eldefrawi *et al.*[4] The rearing of control and test larvæ was carried out at 85° F (± 2) in a cabinet wherein sufficient quantity of water was kept to maintain the temperature throughout the rearing period. The cabinet lid was kept partially open to allow free circulation of air inside the cabinet.

The results of observations on the development, growth of larvæ and pupæ and the fecundity of adults are summarised in Table I.

TABLE I

Effect of synthetic diet on the development of S. littoralis

Food		No. of larvæ in test	Percentage of survival	Mean developmental periods in days			Mean weight in mg.				Mean No. of eggs per female
				Larva	Pupa	Total	Full-grown larva	Pupa	Adult		
									Female	Male	
Castor leaf	..	50	30	14·44	13·00	27·44	880	278	303	199	381·2
Synthetic diet	..	50	92	14·59	12·13	26·72	920	518	483	227	452·6

The data show that though there is no great difference in larval period and pupal period of larvæ fed on the synthetic diet, synthetic diet has enhanced not only the weight of various stages of insects but also increased the fecundity of adults as compared to that of natural food. No difference in hatching of eggs of moths reared on natural food and moths reared on the synthetic diet was observed. The increased mortality in the insect reared on natural food is due to contamination by certain pathogens.

No fungal growth was observed on the diet kept continuously for 5 days. This may be attributed to the addition of methylparaben.[4]

The acceptability of this diet to the castor semi-looper *Achæa janata* L. was also tested. It is interesting to note that the larvæ feed well on this diet.

The authors, are thankful to M/s. Sigma Chemical Company, U.S.A., for having provided some of the chemicals used in the present study.

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Agrl. College and T. R. SUBRAMANIAM.
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LIGHT AND SPORULATION IN *CERCOSPORA PERSONATA* (BERK. *ET* CURT.) ELL. *ET* EVERH.*

Cercospora personata sporulates poorly in culture and loses sporulating character on repeated subculturing.[1] Selective subculturing from spores as well as special media have been recommended to secure sporulation in Cercosporæ. Leach[2] reported that light (visible or near ultraviolet) can induce sporulation in a variety of fungi. Recently, this was found to be effective in the case of *C. beticola*.[3] Two poorly sporulating isolates of *C. personata* made in 1959 and 1967 respectively by one of us (R. N. S.) and maintained on potato-sucrose agar were also induced to sporulate by light. No sporulation occurred if the cultures were incubated in total darkness but profuse sporulation was noticed when plates seeded with mycelial fragments from dark-grown cultures were kept under fluorescent lamps. Sporulation commenced even by the end of 48 hours if the mycelial bits used as inoculum were sufficiently large. If they were smaller, 3-4 days were required for sporulation to start. The medium used apparently had no influence on this since it occurred even on water agar.

It was also of interest to see whether the fungus needed light to sporulate on infected groundnut leaves. Leaves of groundnut variety TMV 2 showing lesions, about 4 mm. in diameter (25 days after inoculation), were washed in distilled water so as to remove any spores already present, blotted dry, and incubated in moist chambers in light and in darkness. After 48 hours the leaves were taken out carefully, suspended in a small volume of water and spores were brought into suspension by shaking with a few glass beads. Spore numbers were then determined with a hæmocytometer. The results are shown in Table I.

TABLE I

Effect of light on spore production by C. personata *on groundnut leaves*

Expt.	No. of spores per [illegible]	
	Light	Darkness
1	136,800 ± 7,100	68,200 ± 8,[illegible]
2	149,900 ± 14,000	63,600 ± 4,100

It is seen that light is not essential for sporulation on the host. However, it increases spore production. In *Helminthosporium gramineum* Houston and Oswald[4] have observed that light is not required for spore production on the host tissues though needed in pure culture. In the present experiment with infected leaves the light treatment was given only after formation of sporophores unlike in experiments on artificial media. This might be the reason why sporulation occurs even in darkness on leaves. This and other aspects of sporulation in *C. personata* are under investigation.

One of us (K. S. B.) thanks the University Grants Commission for the award of a Junior Research Fellowship.

University Botany Laboratory, K. S. BHAMA
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IDENTIFICATION OF SUBSTITUTED BENZOIC AND CINNAMIC ACIDS IN POLLEN GRAINS

THE accumulation of phenolic acids in various forms, free or as glycosides and esters, is known to occur in almost all plant tissues. These organic acids, which are generally synthesized[1,2] from aromatic amino-acid phenylalanine, have been regarded as metabolically inert substances because of their irreversible biosynthetic pathways. Hence, these acids behave as characteristic stable end products.

Although phenolic acids are common constituents of pollen grains, not much work has so far been done in this field. The presence of a number of flavonoids such as quercetin in *Zea mays*,[3] rutin in *Forsythia* sp.,[4] dactylin in *timothy*[5] pollen and a mixture of quercetin, rutin, myricetin, prunin and narigenin in *Acacia dealbata*[6] has been reported. The phenolic acid make-up of some pollen grains, with special reference to phylogeny, has recently been published by Ibrahim.[7]

The results of the investigations on identification of phenolic acids in pollen of *Zea mays*, *Triticum œstivum* (var. Sonora 64), *Brassica nigra*, *Sorghum vulgare* and *Pennisetum typhoides* are reported in this paper.

Pollen was collected immediately after dehiscence, crushed and refluxed with 80% ethanol for 3 hrs. The alcoholic extract was evaporated to dryness and residue dissolved in small quantity of distilled water and filtered.

About half of this filtrate was adjusted to pH 4 by 6 N HCl, extracted with ether, washed with 25% aqueous sodium carbonate solution, the aqueous layer acidified and re-extracted with ether to isolate free phenolic acids.

The remnant filtrate was hydrolysed by 2 N NaOH at room temperature for 5 hours, acidified with 6 N HCl to pH 2, refluxed for 1 hour, extracted with ether and ether extract washed with 25% aqueous sodium carbonate solution. The final extract contained phenolic acids from esters or glycosides.

The ether extracts containing phenolic acids were evaporated to dryness on water-bath, moistened with few drops of 50% ethyl alcohol and spotted on Whatman No. 1, filter-paper for identification by descending paper chromatography. The solvent systems used were, upper phase of a mixture of benzene-acetic acid-water, 6 : 7 : 1 v/v in one direction and a mixture of sodium formate-formic acid-water, 10 : 1 : 200 v/v in the other direction. After drying the chromatograms, identification was done either by viewing under UV light for characteristic fluorescence or by colour reactions with various phenolic sprays.[8]

The results presented in Table I indicate the occurrence of *p*-hydroxy benzoic acid, ferulic (3-methoxy 4-hydroxy cinnamic) acid, caffeic (3, 4-dihydroxy cinnamic) acid, sinapic (3, 5-dimethoxy, 4-hydroxy cinnamic) acid in all the pollen studied. *Zea mays* pollen contain seven phenolic acids while *P. typhoides*, have only four acids. A fifth unidentified spot near the starting point in the first solvent system has also been observed. It was noted that the ferulic acid gave two spots which may be due to the occurrence of its *cis* and *trans* isomers in solution as an equilibrium mixture. In case of caffeic acid, the duplicate spots may be due to conversion of this compound to related coumarin, esculatin in presence of Fe^{++} ions and UV light. The formation of loose complexes by phenolics with each other in crude plant extracts may also result in multiple spots.

TABLE I

Identification of phenolic acids in pollen grains

Sl. No.	Phenolic acid	*Z. mays*	*T. œstivum*	*B. nigra*	*S. vulgare*	*P. typhoides*
1.	*p*-Hydroxy benzoic acid ..	+	+	+	+	+
2.	3-Methoxy-4-hydroxy-benzoic acid	+	–	–	–	–
3.	3, 5-Dimethoxy-4-hydroxy benzoic acid	–	+	–	–	–
4.	3-Methoxy-4-hydroxy cinnamic acid	+	+	+	+	+
5.	2, 5-Dihydroxy benzoic acid ..	–	–	+	+	–
6.	3, 4-Dihydroxy benzoic acid ..	+	+	–	–	–
7.	*o*-Hydroxy cinnamic acid ..	+	–	+	–	–
8.	3, 5-Dimethoxy, 4-hydroxy cinnamic acid	+	+	+	+	+
9.	3, 4-Dihydroxy cinnamic acid	+	+	+	+	+

+ Present, – Absent.

Grateful acknowledgement is made to Dr. M. S. Swaminathan, Director and Principal Investigator and Dr. H. K. Jain, Head, Division of Genetics, for their keen interest and facilities. This research has been financed, in part, by a grant made by U.S.D.A., A.R.S. under PL-480.

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UTILIZATION OF NITROGEN AND TOXIN PRODUCTION BY DIFFERENT STRAINS OF *DRECHSLERA SOROKINIANA*

THE importance of studying the nitrogen utilization of *Drechslera* spp. and its relation to the production of toxins/metabolites is well recognized.[1–3] The present investigation deals with the nitrogen utilization and toxin production by different strains of *Drechslera sorokiniana*, the pathogen causing foot rot disease in wheat. For this purpose, eighteen strains of *D. sorokiniana* were grown in Pyrex Erlenmeyer flasks in 50 ml. Richard's synthetic medium. The initial pH of the culture medium was adjusted to 5·5. After 15 days' incubation observations were made of the following:

(*i*) Mat weight, (*ii*) spore numbers, (*iii*) pH of the filtrate, (*iv*) nitrogen in the mat, (*v*) residual nitrogen (total, nitrate and ammoniacal nitrogen), (*vi*) residual sugar, and (*vii*) units of toxin per ml. of the culture filtrate. Observations on items (*i*) to (*vi*) were made using methods described by Subramanian and Pai.[4] The method of assaying the toxicity of culture filtrates has been described by the author elsewhere.[3]

The results are set out in Table I. It is evident from the data that mat weight, spore numbers, drift in pH, nitrogen accumulated in mat, percentage nitrogen in mat calculated on a dry weight basis, amount of residual nitrogen and sugar, and the amount of toxin produced varied considerably with different strains of the fungus. Some of the strains, *viz.*, 'D' 2, 17, 28, 82, 111, and 'A' showed a higher rate of metabolic activity, as exhibited by growth, in comparison to other strains. The mat weight obtained with these strains ranged from 602–665 mg. Variation in the amount of toxin produced is also quite evident; strains D, 2, 17, for example, produced about 50 units of the toxin per ml. of the culture filtrate and others such as strains 27, 55 and 56 produced much less. Further, as far as the present strains are concerned, no definite correlation existed between (*i*) mat weight and toxin production, and (*ii*) the quantity of nitrogen utilized and the amount of toxin produced. As for example, strains 28 and 42 produced 45·0 units of toxin but the mat weight obtained with these strains were 665 mg. and 405 mg. respectively. Similarly, the amount of nitrogen utilized was highest with strain 111 which produced 36·5

TABLE I

Showing the comparative growth and toxin production by different strains of Drechslera sorokiniana

Strain *	Mat weight (mg.)	Spore numbers per ml. of medium	pH	Nitrogen accumulated in mat (mg.)	Percentage nitrogen in mat	Residual nitrogen (mg.) Total	NO_3-N	NH_3-N	Residual sugar (gm.)	Units of toxin per ml. of culture filtrate
D	614	10 000	6·5	27·16	4·42	41·30	37·45	1·47	0·40	49·5
2	602	12,400	6·4	25·34	4·21	43·54	40·67	..	0·47	49·7
17	656	2,000	6·2	26·50	4·04	41·51	38·57	..	0·30	50·5
27	430	..	5·9	18·20	4·21	50·47	47·74	..	0·63	32·7
28	665	9.000	6·1	24·20	3·64	43·82	40·60	0·42	0·30	45·0
34	508	10,000	6·4	19·32	3·80	48·72	45·50	0·70	0·58	35·0
35	585	..	6·0	28·72	4·91	39·48	37·38	..	0·52	42·0
36	495	..	6·2	24·35	4·92	43·68	40·74	..	0·64	40·0
40	520	..	6·5	19·55	3·76	48·86	45·57	0·35	0·66	42·6
42	405	..	5·7	16·68	4·12	50·75	48·44	0·63	1·09	45·0
52	444	..	5·8	21·35	4·81	46·41	41·93	..	1·00	38·1
55	563	9,000	5·9	23·87	4·24	43·89	39·55	1·40	0·60	34·1
56	585	6,500	6·5	20·82	3·56	47·81	44·59	0·49	1·06	35·5
82	661	8,000	6·2	25·91	3·92	42·70	38·71	0·49	0·32	39·5
89	549	2,500	6·0	27·99	5·10	39·34	36·54	..	0·64	42·5
111	642	5,000	6·1	29·59	4·61	38·64	36·68	..	0·37	36·5
Cmm	586	9,500	6·4	21·97	3·75	46·76	42·63	1·05	0·48	47·7
A	662	9,000	6·1	29·82	4·50	38·78	33·81	2·10	0·30	41·5

* Strain D was isolated by the author from wheat roots. Strains 2 to Cmm were supplied by Dr. B. L. Jain who in the course of studies on variation in the fungus derived these strains by irradiating strain D. Strain A was obtained from Centraalbureau voor Schimmelcultures, Holland. Description of the strains is as follows: strain D (dark, sporulating); strains 2, 28, 35, 55, 56, 82, 89, 111, Cmm (dark sporulating); strains 27, 34, 36, 40, 42, (grey, sparingly sporulating); strain 17 (grey, non-sporulating); strain 52 (albino, non-sporulating); strain A (albino, sporulating).

units of toxin; however, strain 36 which utilized comparatively lesser amount of nitrogen as compared with strain 111, also produced 35·5 units of toxin. Strains 17 and 'A' depleted equal amount of sugar from the culture medium but the amount of toxin produced was higher with strain 17 ([illegible] units) as compared with strain 'A' (41·5 units). Thus, it may be concluded that the amount of toxin produced is mainly governed by the genetic make-up of a given strain.

I am deeply grateful to Professor C. V. Subramanian for guidance and interest in this investigation and also in the preparation of this paper.

Punjab Agricultural Univ., P. D. Tyagi.
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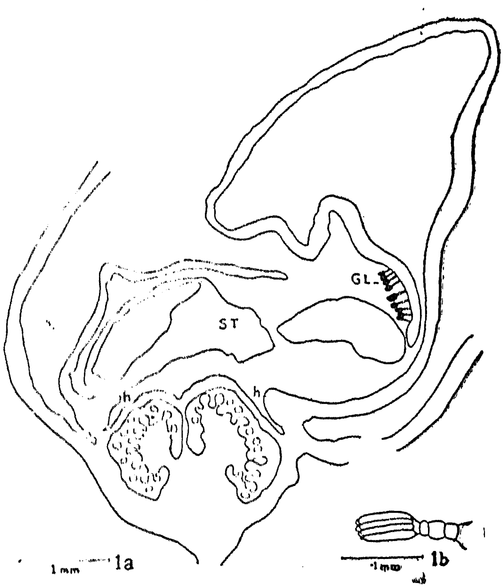
ON THE FLORAL MORPHOLOGY OF *CALCEOLARIA TRIPARTITA* RUIZ AND PAVON

The gynoecium in the Scrophulariaceae is bicarpellary syncarpous with the ovary usually superior. A "nectariferous annular or unilateral disc"[4] is generally present. The observations made on *Calceolaria tripartita*, however, reveal some noteworthy features of morphological interest and these are detailed below.

An earlier account on *Calceolaria* states[1] that "calyx basi ovario brevissime subadhaerens" and "discus tenuis, calyci adnatus". In the present plant, the calyx and the corolla are basally united into a tube to which the ovary is adnate to about at least the middle of its length (Fig. 1 *a*). The ovary thus appears semi-inferior. The magnitude of the union of the floral whorls is of a marked degree and has resulted in the fusion of their principal vascular cords as well.

Another interesting feature observed in this plant, and in none of the 40 odd species investigated here is the fact that the disc is totally absent. What is probably referred to as a disc in the earlier account[1] appears to be actually a hump of the corolla which closely collars the ovary (Fig. 1, *h*). It is not nectariferous. Instead, the larger lip of the corolla develops prominent glandular outgrowths which seem to serve a secretory function (Figs. 1 *a*, GL; 1 *b*).



FIGS. 1 *a*, *b*. Fig. 1 *a*. L.S. of the flower of *Calceolaria tripartita*, GL—Glands; *h*—Hump; ST—Stamen. Fig. 1 *b*. A gland magnified.

In his recent extensive study of the floral nectaries, Fahn[2] concluded that "the main phylogenetical trend of the location of the nectary in the flower is acro-centripetal". However, he also recognized a "secondary migration" of the nectary to the perianth in certain highly specialized taxa.

The present species certainly shows a high degree of specialization in flower structure. Reduction and modification, and fusion of the members of the perianth as also the fusion of the principal vascular cords of the floral whorls and the development of a semi-inferior ovary are met with. It seems very likely that there is a "secondary migration" of the nectariferous tissue here as well, probably concomitant with the development of a semi-inferior ovary, and the disc, so very characteristic of the family, is replaced by glandular emergences of the corolla.

Furthermore, in the allied family Gesneriaceæ, the overy is 'superior or half-inferior or wholly inferior".[4] An investigation of this family and the Calceolariaceæ should, therefore, be of particular interest.

Incidentally, it may be noted that the present plant does not appear to be recorded in the Indian floras. *C. mexicana* Benth. is the species which is stated as naturalized in and around Darjeeling.[3] The present species was also collected from the same locality and has run wild there.

The writers are deeply grateful to the Director, Royal Botanic Gardens, Kew, for the determination of the species. They thank Prof. K. B. Deshpande for his kind interest.

Department of Botany, S. V. RATNALIKAR.
S.B. College, Aurangabad,
and
Department of Botany, R. M. PAI.
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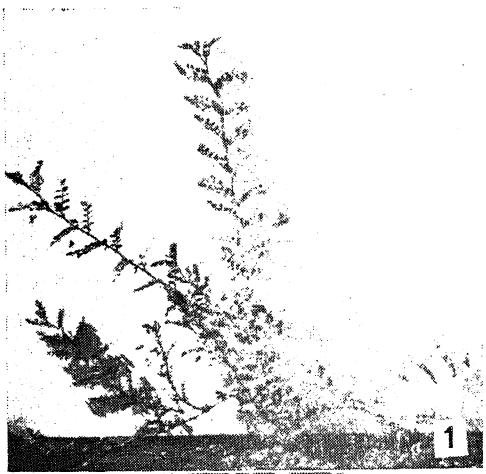
COLCHICINE-INDUCED TRIPLOIDY IN GRAM (*CICER ARIETINUM* L.)

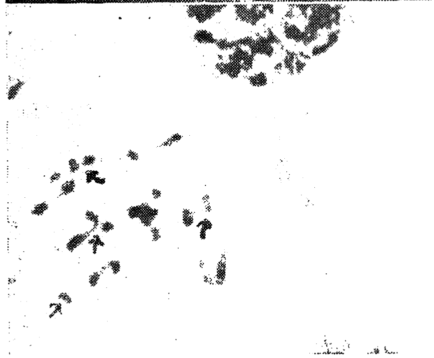
TRIPLOIDS generally help in studies of chromosome behaviour in meiosis. There are numerous reports on meiosis in triploid plants.

The authors came across only one reference to cytological behaviour of a triploid in the genus *Cicer* by Meenakshi and Subramaniam (1966), where they reported the occurrence of few triploid cells. However, they made no reference regarding the behaviour of chromosomes during meiosis.

In polyploid *C. arietinum* developed and under study at the Agriculture College, Nagpur, the authors came across a plant which was quite vigorous in its growth but looked different in habit. This plant had more laterally spreading branches, with only one or two erect ones. On some of the branches there were secondary branchlets. Excepting these the development of leaflets and of flowers was quite normal (Fig. 1). To study the chromosomal behaviour during meiosis in this plant, the flower-buds were fixed early in the morning in acetic alcohol (1 : 3). After 24 hours of fixation, a few drops of ferri-acetate were added as a mordant.

The earlier stages of meiosis could not be studied owing to an unsatisfactory separation of chromosomes. Fairly clear plates were obtained of Metaphase I. All the cells had 24 chromosomes in the form of univalents, bivalents and trivalents (Fig. 2). The frequency of trivalents varied from 0 to 3 per p.m.c. and that of univalents from 0 to 4. The anaphasic separation was found to be irregular resulting in the formation of abnormal pollen grains. The pollen grains stained with 1% aceto-carmine were abnormal in size. This may be due to their unbalanced chromosome number. The plant was sterile as there was no seed setting. The pollen grains from the diploid and tetraploid plants were transferred on the flowers of this plant to get some seeds. There was, however, no seed-setting. Although triploidy has been found helpful in the improvement of fruit crops propagated vegetatively (Allard, 1969) it is of little utility in *C. arietinum* where vegetative propagation is not possible.





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FIGS. 1–2. Fig. 1. Showing vigorous growth of the triploid plant. Fig. 2. Metaphase I, showing 3 III^s, 7 II^s and 1 I, × 1,000.

Botany Section, B. A. PHADNIS.
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AMINO-ACIDS IN EASY AND DIFFICULT-TO-ROOT STEM CUTTINGS OF *GUAVA* (*PSIDIUM GUAJAVA* L.)*

For propagation of plants by stem cuttings, which is more economical, certain type of growth, *e.g.*, the invigorated shoots obtained from a beheaded tree, gives better rooting than the non-juvenile shoots. The differential rooting behaviour of these two types of shoots may be due to various factors. White[1] observed that certain amino-acids were essential for the growth of excised tomato roots, *e.g.*, glutamic acid, lysine, histidine, phenylalanine, leucine, isoleucine, valine, serine and proline. Later, Went *et al.*[2] suggested that rooting might be limited by lack of certain amino-acids in the tissues. White's view was confirmed by the work of Doak[3] and Salisbury and Parke.[4] Bhandary and Mukherjee[5] reported 40% rooting in *guava* stem cuttings with the invigorated shoots obtained from a beheaded tree, treated with 5000 ppm of IBA, against the non-juvenile cuttings giving only 10% rooting.

The present study was undertaken to find out the difference in amino-acid contents in these two types of tissues of *guava* stem cuttings, selected from a single *guava* tree. A known quantity of fresh material was taken and amino-acids and amides were extracted with 80% ethanol, and purified by Plaisted[6] method. Two-dimensional paper chromatography as suggested by Porter *et al.*[7] was employed for the separation of free amino-acids and amides and quantitative determination of aspartic acid, glutamic acid and threonine. The separated amino-acids were identified by (*i*) comparing the Rf values with the known standards (*ii*) co-chromatography of the known synthetic amino-acids along with the plant extract and (*iii*) using various spray reagents as suggested by Block *et al.*[8]

The amino-acids identified in these two types of tissues are shown in Figs. 1 and 2.

The qualitative determination of amino-acids showed that the invigorated and non-juvenile shoots differed from one another only in respect of lycine and tyrosine. While lycine was absent in invigorated shoots, it was present in the non-juvenile, tyrosine was present in the former but absent in the latter. The quantitative estimation of threonine, aspartic acid and glutamic acid showed a marked increase of these substances in the invigorated tissues than in the non-juvenile ones. Herman and Hess[9] working on *Hibiscus rosasinensis* and *Phaseolus vulgaris* found increase in valine, threonine, aspartic acid and asparagine and, in some cases, glutamic acid by etiolation which also increased rooting ability. The qualitative and quantitative differences in amino-acids observed in the present study in the non-juvenile and invigorated shoots of *guava* might be one of the factors responsible for decreasing

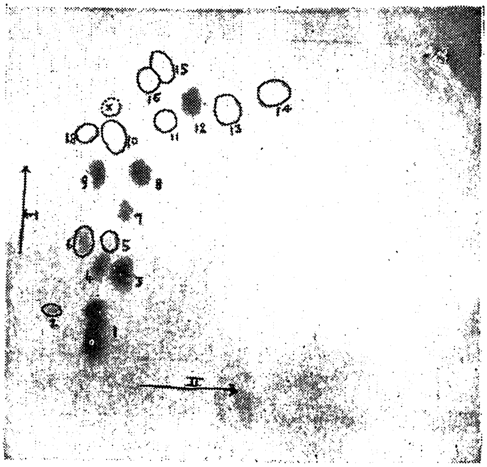

FIG. 1

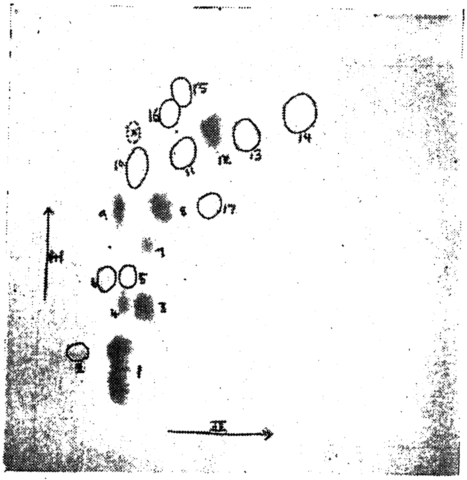

FIG. 2

FIGS. 1–2. Photos of chromatograms of extracts from non-juvenile (Fig. 1) and juvenile (invigorated) shoots (Fig. 2) of *guava*. Solvent system: I. Phenol: Water (4 : 1). II. *n*-butanol : Acetic acid : Water (4 : 1 : 5). 1. Aspartic acid. 2. Cystine. 3. Glutamic acid. 4. Serine. 5. Glycine. 6. Asparagine. 7. Threonine. 8. L-alanine. 9. Glutamine. 10. Hydroxy Proline. 11. Gamma-amino butyric acid. 12. Valine/Methionine. 13. Leucine/isoleucine. 14. Phenyl alanine. 15. Proline. 16. B-alanine. 17. Tyrosine. 18. Lycine.

rooting ability in the non-juvenile and increasing the same in the invigorated stem cuttings of *guava*. Therefore, it would be worthy of wider investigation to find out whether and to what extent individual amino-acids influence rooting in different species of plants.

Bot. Survey of India, K. R. BHANDARY.**
14, Madan Street, S. K. MUKHERJEE.
Calcutta-13, *August* 14, 1969.

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* The investigation was conducted at IARI, Delhi, as part of a *Ph.D. Thesis* by the senior author.

** Present address: Department of Horticulture, Lalbagh, Bangalore-4.

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THE ROLE OF VIVIPARY IN THE GENUS *CYMBOPOGON*

DURING the studies on the genus *Cymbopogon* Sprengel for last ten years, the authors have been noticing viviparous development of the seeds, that is, their germination while still within the spikelets and attached to the parent plants. These seedlings burst through the hanging inflorescence and continue to grow till they fall on the ground. The roots fix the seedlings in the soil and give rise to new populations. Young seedlings are frequently seen growing in the neighbourhood of the plants under consideration. This feature has been utilized for colchine treatment for induction of polyploidy. Vivipary has been reported[1,3,6,7] in number of genera of grasses like *Poa, Festuca,* and *Deschampsia*. This is the first time it has been recorded[1,3] in the members of series *Citrati* of the genus *Cymbopogon* which includes *C. nardus* (Linn.) Rendle, *C. confertiflorus* (Steud.) Stapf and *C. flexuosus* (Nees ex Steud.) Wats.

One of the noteworthy observations in the genus *Cymbopogon* is that vivipary is restricted to strains of hybrid origin or, suspected to be hybrids. The diploid strains, showing this feature, form a gradual series of intermediate forms between *C. flexuosus* and *C. confertiflorous* and make the delimitation of two species very difficult. A similar finding has been reported[7] by Stebbins in case of many plants. The tetraploid strains belonging to *C. nardus* and *C. flexuosus* are of hybrid origin.[4,5] A hexaploid strain of *C. confertiflorus* collected from Pykara Falls (Nilgiris) in the year 1964 also showed proliferations once in these six years. Another striking feature met during this investigation is the absence of vivipary in true species of *C. flexuosus* and *C. confertiflorus* which are diploids.

Thus vivipary is due to some genetic disturbances caused by natural hybridization which is common in many species of *Cymbopogon*.[2]

This phenomenon is of great interest to plant breeders for the propagation of particular strains and also provides excellent material for induction of polyploidy by artificial means.

Regional Research Lab., E. K. JANAKI AMMAL.
Jammu,
and
Post-Graduate B. K. GUPTA.
Dept. of Botany,
DAV College,
Dehra Dun, *October* 21, 1969.

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REVIEWS AND NOTICES OF BOOKS

Elementary Statistics. By G. Hadley. (Holden-Day, Inc., 500, Sansome Street, San Francisco 94111), 1969. Pp. xi + 457. Price $ 9.75.

This text is intended for a one-semester introductory course in statistics for students in both the social and biological sciences or for use as a text in some of the new general courses taught to students with a considerable diversity of interests. The level of presentation is elementary; no calculus is used. However, probability theory is developed in more depth than is typical for texts at this level. The notion of a probability model and its relation to reality is emphasized.

Special features of this book are: 1. Emphasizes a clear and logical development at an elementary level; 2. Devotes an entire chapter to modern decision theory, including Bayesian statistics, and treats the classical theory of decision making based on hypothesis testing in a separate chapter. This makes it possible to cover exclusively the classical approach, or the new decision theory methods, or some combination of both; 3. Contains a novel treatment of time series which emphasizes their probabilistic nature; 4. Provides a very large number of interesting examples from many different fields, including genetics, economics, business, agriculture, and everyday life; and 5. Includes over 750 problems to illustrate the wide range of applicability of the material studied. C. V. R.

Transition Metal Chemistry (Vol. 4). Edited by Richard L. Carlin. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016, U.S.A.), 1969. Pp. x + 305. Price $ 15.75.

This series is devoted to the science of the transition elements and is geared to research scientists, graduate students, and teachers of advanced inorganic chemistry. As transition metal chemistry is one of the oldest and largest areas of research in inorganic chemistry, the many facets of progress are surveyed regularly, attention being paid to both theoretical and experimental aspects, as well as the borderline areas. New subjects of transition metal physics and transition metal biology are also reviewed as it is here that some of the more important further discoveries will be made.

The contents of volume 5 are listed below: 1. The Spectra of Chromium (III) Complexes, by Leslie S. Forster; 2. Copper Complexes, by William E. Hatfield and Robin Whyman; and 3. Metal-Metal Exchange Interactions, by Gerald F. Kokoszka and Gilbert Gordon. C. V. R.

Physics of Solids in Intense Magnetic Fields. Edited by E. D. Haidemenakis. (Plenum Press, New York), 1969. Pp. xx + 483. Price $ 27.50.

Over one hundred scientists from a number of Western European countries, Australia, Canada. Israel, Japan, and the United States gathered on the island of Crete to discuss the physics of solids in intense magnetic fields. It was six years ago that many of the participants were discussing the production and technology of high fields at the MIT Conference. This volume contains, in large measure, the proceedings of the Crete gathering.

The titles of the articles contained in this volume are: The Interaction of Acoustic and Electromagnetic Waves with Plasmas in a Magnetic Field; Intraband Collective Effects and Magnetooptical Properties of Many-Valley Semiconductors; Effects of Band Population on the Magnetooptical Properties of the Lead Salts; The Coupling of Collective Cyclotron Excitations and Longitudinal Optic Phonons in Polar Semiconductors; Application of Gas Lasers to High-Resolution Magnetospectroscopy; Quantum Magnetooptics at High Fields; Magneto-Quantum-Electric Effect; Electron Band Structure Studies Using Differential Optical Techniques and High Magnetic Fields; High Field Magnetospectroscopy and Band Structure of Cd_3As_2; Effects of High Magnetic Fields on Electronic States in Semiconductors The Rydberg Series and the Landau Levels; Faraday Rotation in Solids; A Technique for the Measurement of the Faraday Effect in Pulsed Magnetic Fields at Low Temperatures; Electrons in a Magnetic Field; Bloch Electrons in Crossed Electric and Magnetic Fields; Group-Theoretical Approach to the Problem of a Bloch Electron in a Magnetic Field, Tight-Binding Approximation for a Bloch Electron in a Magnetic Field; The Zeeman Effect in Crystals; Magnetic

Breakdown; Ultrasonic Propagation in High-Field Superconductors; Giant Quantum Oscillations in Ultrasonic Absorption; Helicon Propagation in Metals: Quantum Oscillations in Tin; The Shubnikov-de Haas Effect and Quantum-Limit Phenomena in Semiconductors; Hall Effect and Transverse Voltages in Type-II Superconductors in the Mixed State; Experiments on the Critical Behavior of Type-II Superconductors in High Magnetic Fields; and Megaoersted Fields and their Relation to the Physics of High Energy Density. C. V. R.

A Functional Bestiary—Laboratory Studies About Living Systems. By S. Vogel and S. Wainwright. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W 1, England), Pp. 106. Price 15 *sh.*

This manual is a collection of exercises designed to be used in the laboratory section of an introductory biology course. Most of the material concerns phenomena at the organismal level of organization, rather than essentially cellular or molecular in outlook. The authors have emphasised on physical models to illustrate the essential priciples underlying the functioning of biological organisms. As is pointed out in the Preface "This manual is a guide designed to help a very large number of people spend a very small amount of time in a useful manner", and that too with ordinarily available equipment. A. S. G.

Rothamsted Experimental Station: Report for 1968. Part I, 404 pages; Part II, 215 pages. Price for both parts £ 1-10-0; for Part II only £ 1-0-0. Obtainable from the Librarian, Rothamsted Experimental Station, Harpenden, Herts, England.

This well-known Annual Report of the Rothamsted Experimental Station for the first time appears in two separate volumes. The double issue will be a welcome feature of further Reports also.

Part I contains the General Report and the Departmental Reports from the various Divisions of the Station, the Fields and the Farms Experiments, and also the Abstracts of Papers published during the year.

Part II will now be devoted to review articles, especially those dealing with the Station's long-term field experiments, and other articles of a similar nature that will be of general importance.

This year, appropriately enough, Part II deals exclusively with one subject, namely, the experiments with wheat on Broadbalk Field. It reviews the whole work done during the history of this classical experiment from 1843 onwards on the nutrition of wheat. The review chapters contributed by staff members and workers who have been long connected with these experiments, are under the following heads: Historical Introduction; Yields; The Plant Nutrients in Crops Grown on Broadbalk; The Soils of Broadbalk; Diseases; Insect Pests; Nematode Population Studies; Microbiology of the Broadbalk Soils; and Weed Studies. A. S. G.

Proceedings of the International Symposium on Plant Growth Substances. Edited by S. M. Sircar. (Published by S. M. Sircar, Bose Institute, 93/1, Acharya Prafulla Chandra Road, Calcutta-9), Pp. 538. Price Rs. 25·00.

An international symposium on Plant Growth Substances, sponsored jointly by the University Grants Commission and Department of Botany, Calcutta University, was held in Calcutta, from January 23-28, 1967.

The publication under review contains the Proceedings of the Symposium. It starts with the Inaugural Address of Professor P. Parija, followed by the Address by Professor J. van Overbeek on Plant Hormones.

The sixty papers presented at the Symposium are arranged under the following sections: Naturally Occurring Growth Substances—Extraction, Isolation, Identification and Bioassay (8 papers); Relation of Growth Substances to Organ Formation (20 papers); Use of Growth Regulators in Agriculture and Horticulture in India (24 papers); and Growth Regulating Chemicals for the Destruction of Weeds in India (8 papers). A. S. G.

Books Received

Physics of Solids in Intense Magnetic Fields. By E. D. Haldemenakis. (Plenum Press, New York, N.Y. 10011), 1969. Pp. xx + 483. Price $ 27.50.

Annual Review of Medicine (Vol. 20). (Annual Reviews, Inc., California, U.S.A.), 1969. Pp. viii + 499. Price: U.S.A. $ 8.50; Foreign $ 9.00.

1576-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.

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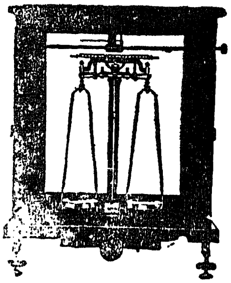

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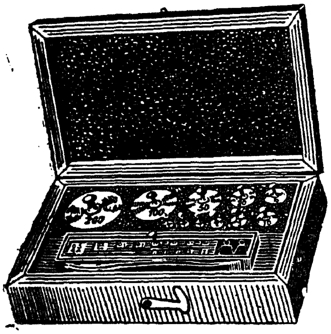

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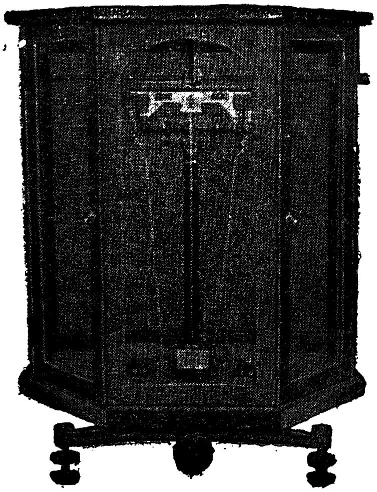

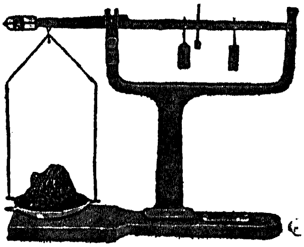

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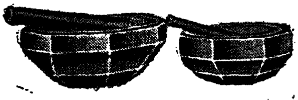

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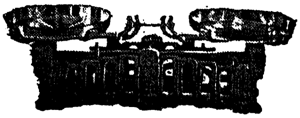

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THE VARIED COLOURS OF *VERBENA*

SIR C. V. RAMAN

THE garden *Verbenas* are very popular trailing plants of a perennial habit. They strike root as the shoots trail along the surface of the soil and meet with sufficient moisture. It is then possible to separate the rooted portions of the shoots from the parent and grow them independently. *Verbenas* are very serviceable as ground cover in shrubberies, for hanging baskets, for rockeries, for growing in beds and for pot culture. There are several species or varieties which have received distinctive names, *viz.*, amongst which mentioned *Verbena hybrida, Verbena erinoides* and *Verbena peruviana.* The flowers of *Verbena* are produced in great profusion. They stand up well above the foliage in large velvety clusters of elegant shape. *Verbena erinoides* is also known as the Moss *Verbena* as the plants cover the ground completely.

Books on gardening stress the wide range of colours exhibited by the *Verbenas*. In one book, we find illustrations of a cluster of intensely blue flowers of *Verbena hybrida* and of a cluster of brilliant scarlet flowers of *Verbena peruviana*. The author of another book goes so far as to say that "there are very few flowers which can beat the *Verbena hybrida* in the exquisite range of colours, varying from white through blue and rose to purple and dark purplish-blue, with shades of pink and pale yellow". It is evident, therefore, that *verbenas* would be excellent material to illustrate the relationship between the observed colour and the spectroscopic behaviour of flowers.

Blue *verbenas* would be of particular interest as they may be expected to display the spectral characteristics of Florachrome A. At the time of writing, however, they were not to be seen in Bangalore. A purple species of *Verbena* is however quite common, and when as is frequently the case, it has been planted over an extensive area, the ground covered with the flowers presents the appearance of a carpet of that colour. Though the individual flowers are small, a cluster of them presents a substantial area, and its spectral character may be readily determined by viewing the cluster through a pocket spectroscope. An absorption band covering the yellow region of the spectrum is a striking feature, while the green region is visible and by comparison appears fairly strong. The red and blue regions of the spectrum are seen with apparently undiminished strength. The colouring matter of the purple *verbena* is readily extracted by immersing the flowers in acetone. A spectrophotometric record obtained with a cell of one centimetre thickness containing the extract is reproduced as Fig. 1. The record exhibits three peaks of absorption, one of which appears in the yellow region of the spectrum and the other two respectively in the green and the green-blue regions. These spectral characteristics may be identified as those of Florachrome B. The purple *verbena* furnishes an excellent example of the role that the absorption of the yellow plays in the perception of a purple hue.

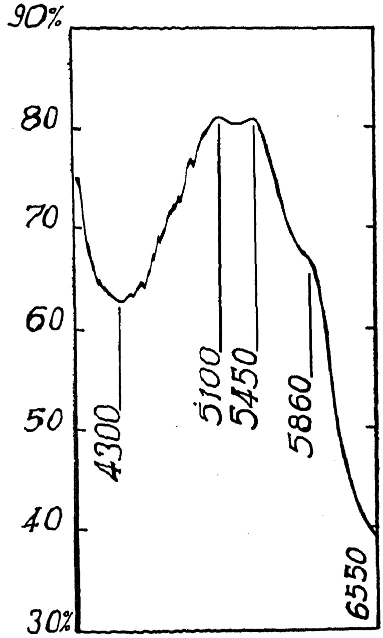

FIG. 1. Absorption Spectrum of acetone extract from purple *verbena*.

In the author's garden at his Institute in Bangalore, a variety of *Verbena* is to be seen, the colour of the flowers of which may be described in general terms as being red. But it is highly variable, varying from a deep purplish-red to quite a pale pink. These differences appear partly to be due to a gradual fading away of the individual flowers, since those nearer the centre of the cluster which are the latest to open have the deepest colour, while the outermost are the palest. Spectroscopic examination of the individual flowers in a cluster reveal that the absorption appearing in the spectral region between 500 mμ and 600 mμ which is responsible for the observed colour is very weak in the flowers which appear a pale pink, and is almost complete in those which exhibit a brilliant colour. The relative intensity of the absorption appearing in the green sector from 500 mμ to 560 mμ and in the yellow sector from 560 mμ to 600 mμ is also highly variable. The observed colour appears to be most saturated when the yellow sector is completely absorbed. This is indeed a general feature in all floral colours.

The spectrophotometer record reproduced above was made in the Instruments Section of the Indian Institute of Science to the authorities of which the author's thanks are due.

CELLULAR HETEROGENEITY AND METABOLIC ADAPTATION IN THE FLIGHT MUSCLES OF DRAGONFLIES

J. C. GEORGE
Department of Zoology, University of Guelph, Guelph, Ontario, Canada

It is well known that the vertebrate skeletal muscle consists of two basic types of fibre, red (Type 1) and white (Type 2). In the pigeon pectoralis muscle, the red fibres are characterized by their small diameter, higher content of myoglobin, fat, mitochondria and, lipolytic and oxidative enzymes. The white fibres have larger diameter, higher content of glycogen and glycolytic enzymes. The former are adapted for aerobic metabolism and metabolize fat as the chief fuel. The latter are adapted for anærobic metabolism for metabolizing glycogen. The pigeon pectoralis muscle consists of only the red and white fibres, the intermediate forms that are found in other vertebrate muscles being absent. The white fibres are present in the periphery of the muscle fasciculus and the red fibres which have a greater blood supply occur towards the interior. The pectoralis muscle of the sparrow on the other hand, consists of only the red fibres. The fibres in the superficial region of this muscle, however, have been shown to contain more glycogen and phosphorylase and less fat and succinic dehydrogenase than the fibres in the deeper part of the muscle. Thus the pigeon and sparrow pectoralis muscles represent in avian flight musculature, two lines of evolution in cellular architecture and functional adaptation. Similar parallelism in the evolution of the pectoralis major muscle in bats has also been indicated.[1,2] Recently, Kallapur[3] reported the occurrence of two types of fibre, one larger and more sudanophilic than the other in the leg muscle of two species of cockroaches *Blatella germanica* and *Periplaneta australasiæ*. The former type of fibre resembles the third type of fibre, large, red, and containing high concentrations of fat, lipase and succinic dehydrogenase described by Nene and George[4] in the avian supinator muscle.

In the case of the flight (basalar and dorso-ventral) muscles of dragonflies too, parallel trends in the nature of their fibre composition as observed in the pectoralis muscle of some birds and bats could be recognized.[5] The two types of fibre, the small (20–30 μ in diameter) and the large (40–70 μ in diameter) in the dragonfly *Pantala flavescens* may be compared to the red (Type 1) and white (Type 2) fibres respectively of the pigeon pectoralis muscle. There is, however, a difference between the pattern of distribution of these fibre types in the muscles of the two animals. In the pigeon muscle, the large white fibres mostly occur at the periphery of the muscle fasciculus, and in the muscle as a whole, the superficial region has a considerably larger population of white fibres than in the deeper part.[2] In the flight muscle of *Pantala flavescens*, however, the large fibres show a scattered distribution. The fibre composition of the flight muscles of the two dragonflies *Aeshna* sp.[6] and *Anotogaster sieboldii*[7] correspond to that of the pectoralis of the sparrow.[5] In *Anotogaster sieboldii*, the peripheral fibres in a fasciculus have been shown to contain lower levels of oxidative enzymes than the deeper fibres.[7] The fibre composition of the flight muscle of *Brachythemis contaminata* is similar to that of the flight muscle of *Anotogaster sieboldi* and is also comparable to that of the pectoralis muscle of the sparrow in that the peripheral fibres contain more glycogen but less fat and oxidative enzymes. Recently, Bhat[8] reported differences in the intensity of staining for fat and glycogen in the fibres of the flight muscle of *Brachythemis contaminata*. However, he does not mention which flight muscle was studied. The basalar and dorsoventral muscles in this dragonfly have the same fibre architecture and the photomicrographs presented therefore seem to be representative of these two muscles. The presence of a greater amount of glycogen in the peripheral fibres and a higher level of fat in the inner fibres of a muscle fasciculus, is by no means an unique feature seen in these muscles since the peripheral fibres in the sparrow pectoralis muscle also contain more glycogen and less fat than the deeper fibres.[2] Moreover, these observations would be more meaningful for a better understanding of muscle structure and function if they are viewed in the broad spectrum of cellular heterogeneity and metabolic adaptation in skeletal muscles in general.

In contrast to the vertebrate skeletal muscle, the insect flight muscle with its profuse supply of tracheoles in addition to blood, is essentially a highly ærobic tissue. In terms of fuel consumption and oxygen uptake, the insect flight muscle is the most active tissue known.[6] Weis-Fogh[6] considers muscular pumping of blood essential in all active wing muscles and the high concentrations of trehalose and of lipids in the insect blood as an adaptation to flapping flight. In this context the recent discovery of special myofibrils attached to the capillary wall in the pigeon pectoralis muscle is suggestive of the importance of muscular pumping as an effective process for the supply of oxygen and metabolites to the contracting muscle.[9] In the insect flight muscle, adequate supply of the fuel for energy during the initial period of muscular activity could be obtained through the combined effect of the presence of a high concentration of trehalose in the blood and of the muscular pumping.[6] In prolonged muscular activity however, fat would be the preferred fuel.[10,11] It should be of interest to know if the large fibres in the flight muscle of *Pantala flavescens* and the peripheral fibres in the muscle of the other dragonflies (*Aeshna* sp., *Anotogaster sieboldi*, *Brachythemis contaminata*) would preferably metabolize carbohydrate and continue to do so while the smaller or the inner fibres, as the case may be, metabolize fat as the chief fuel during prolonged muscular activity. It is known that in cockroaches[12] and in locusts[6] the supply of trehalose is completely used up initially during prolonged flight, after which fat becomes the fuel. In the pigeon pectoralis muscle the white glycogen-rich fibres were shown to be depleted of their glycogen reserves within ten minutes of electrical stimulation of the muscle while the glycogen content of the red fat-utilizing fibres showed slight increase.[13] The increased synthesis of glycogen in the red fibres may be to provide a continuous supply of oxaloacetate for the oxidation of fatty acids for energy in these fibres. The white fibres have been characterized as fast-twitch fibres and the red as slow-twitch fibres, the former indulging in phasic contractions for short durations of time and the latter in prolonged activity.[9]

It has been shown recently that in insects there is a preflight activity during which the temperature of the thorax is considerably increased.[14] During this "warmup" period there is no visible wing movement. Perhaps, the contractile activity of the specialized glycogen-utilizing fibres in the muscle may be responsible for the generation of the required preflight heat.

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STUDIES ON ORGANO-METALLIC INTERACTIONS IN THE MARINE ENVIRONMENT*

Part 2. Interaction of Metallic Ions with Humic Acid from a Marine Sediment

ELIZABETH KOSHY, M. V. M. DESAI AND A. K. GANGULY

Health Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-85. (AS), India

ABSTRACT

Sorption of radionuclides in sea-water by humic acid prepared from a marine sediment yielded distribution coefficient values (K_d) of the order of 10,000 for Mn, Co, Zn and Y. Solubilization of Ba, Mn, Zn, Co, Fe, Y and Zr-Nb was observed in ammonium humate; Ba was in the form of cationic and/or cationic complexes, whereas Mn, Zn, Co, Fe, Y, Zr-Nb formed significant proportions of 'nonionic' or 'anionic' complexes. These complexes were comparable to EDTA complexes in their behaviour on the ion exchange column. The attainment of equilibrium in the solubilization or complexing process has been observed to be slow, ranging from days to a month.

INTRODUCTION

HUMIC ACID is an ion exchange material, but adsorption or solubilization of metal ions and metal compounds by the acid (or humate) is not necessarily associated with its exchange centres or related to its exchange properties. Pillai *et al.*[1] observed the presence of trace elements even in highly purified humic acids indicating sites within the humic acid for bonding metal ions. Alexandrova[2] suggested that aluminium and iron are included in the anionic part of the humus compound. Kononova[3] indicated the association of trace elements and rare elements with humic substances in the form of chelates. Schnitzer and Skinner[4] reported that soil organic matter (the NaOH extract, mainly of humic substances) forms stable water-soluble complexes with elements such as Fe^{+++}, Al^{+++}, Ca^{++}, Mg^{++}, Cu^{++} and Ni^{++}. Basu *et al.*,[5] in their studies with humic acid, found that the ion desorption curves were always lower than the adsorption curves indicating the possible formation of a complex. Zinc was found to be more strongly bound on humic acid than calcium, but less strongly than copper or ferrous iron by Randhawa and Broadbent.[6] Mortensen[7] stated that the studies which have suggested that soil organic matter is able to chelate metals have relied on indirect evidence. The present work was conducted, in this context, namely, to study the sorption and solubilization of metal ions present by humic acid extracted from a marine sediment.

EXPERIMENTAL

Preparation of Humic Acid

Humic acid was extracted repeatedly from a marine sediment (collected from near-shore region of Bombay) by a 0·2 N NaOH-Na_2CO_3 solution. Treatment was for 6 hours at 80° C. in air, the insoluble sediment centrifuged out and the humic acid was precipitated by HCl at pH 2. The precipitate was purified by repeated dispersion in alkali, filtration (all filtrations in this preparation and in experiments to follow were also carried out with 0·22 μ Millipore membrane filters), precipitation by acid, dialysis, and prolonged electrodialysis at 200 V. The stock humic acid (pH 3·2 and base exchange capacity of 383 meq./100 gm.) thus prepared was stored in a glass bottle which was rigorously cleaned with aqua regia followed by steam cleaning for 80 hours and repeated washing with DDW.

Sorption of Radionuclides by Humic Acid in Sea-Water

Freshly collected sea-water from Bombay Harbour was allowed to settle for 24 hours and the supernatant water was filtered. The filtered sea-water (pH 7·8) was used for the sorption experiments. Doubly concentrated sea-water (DCSW—pH 8·4) was prepared by evaporating the sea-water to half its original volume under an infrared lamp and then filtering it. (This water was used in the experiments to compensate for the dilution on the addition of a volume of sodium humate to the filtered sea-water.) The sodium humate (pH 7·9) was obtained by dropwise

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* Our thanks are due to Shri T. N. V. Pillai, for his continued help in the preparation of humic acid.

addition of caustic soda to humic acid solution. Aqueous solutions of the compounds (*see* Table I) of the following isotopes, Mn^{54}, Fe^{59}, Co^{60}, Cu^{64}, Zn^{65}, Y^{90} and Cs^{134} were used in the experiments.

To two steam-cleaned 250 ml., wide mouth reagent bottles were respectively added:

Bottle 1—Control: 90 ml. sea-water; 5 ml. DCSW, 5 ml. DDW (pH of mixture 8·0).

Bottle 2—Sample: 90 ml. sea-water and 5 ml. DCSW (pH of mixture 8·0).

A known measured equal volume (~ 100 λ) of the isotope solution was added to each of the bottles, shaken well, and left to equilibrate. The total carrier of each element present in the system is given in Table I. There was no change in pH on addition of the isotope solutions. Definite volumes from Bottle 1 were withdramn at 24-hour intervals immediately after thorough shaking, and aliquots (1 ml.) were counted before and after filtration. Equilibrium was assumed in both the bottles when the activity in the control filtrate remained unaltered for two successive days. **Sodium humate (5 ml., 12·84 mg.)** was then added to Bottle 2, shaken well, and set aside for coagulation and settling (~ 4 hours) of humic acid. A very faint straw yellow colour, indicating solubilization of a part of humic acid in the medium was observed in the clear supernatant liquid. The control and sample bottles were shaken, specific volumes were withdrawn and filtered and aliquots (1 ml.) of the filtrate were counted. The difference between the two counting rates multiplied by the total volume of liquid in the sample bottle was calculated to show the extent of sorption of activity by humic acid in sea-water. All counting statistics were below the standard deviation of ± 2%. Solution of any precipitated activity in Bottle 2 by the humate has not been considered in the discussions to follow. The values of the distribution coefficient,

$$K_d = \frac{\text{Sorption of activity per g. of humic acid}}{\text{Activity per ml. filtrate of the sample}},$$

for a particular radionuclide were determined at different time intervals over prolonged periods. Results are shown in Tables II and III. The activity (625 cpm/ml.) of the filtrate from Fe^{59}-humic acid mixture, during the sorption experiments as above, was about four times higher than that of the filtrate from the control (144 cpm/ml.). This anomalous behaviour of Fe^{59} suggested the possible solubilization of Fe by the dissolved fraction of the humic acid.

TABLE I

Chemical forms, decay characteristics and carrier contents of the isotopes used in sorption experiments

Isotope	Half-life	Mode of decay	Chemical form	Total carrier (μg/l.)
Mn^{54}	291 d.	EC, gamma	$MnCl_2$	2
Co^{60}	5·27 y.	Beta, gamma	$CoCl_2$	1·7
Cu^{64}	12·8 h.	Beta, EC, gamma	$CuSO_4$	225
Zn^{65}	245 d.	$Beta^+$, EC, gamma	$ZnCl_2$	60
Y^{90}	64·2 h.	Beta	YCl_3	756·6
Cs^{134}	2·2 y.	Beta, gamma	CsCl	110·5
Fe^{59}	45 d.	Beta, gamma	$FeCl_3$	15·2

TABLE II

Sorption of Mn^{54}, Co^{60}, Zn^{65} Y^{90} and Cu^{64} by humic acid in sea-water

Mn^{54}		Co^{60}		Zn^{65}		Y^{90}		Cu^{64}	
Time (days)	K_d	Time (days)	K_d	Time (days)	K_d	Time (days)	K_d	Time (hours)	K_d
0·17	1285	0·17	10640	0·17	11140	0·17	12230	17	4625
2	2133	2	11350	3	11150	1	15360	24	5208
6	4059	7	11320	7	13030	2	15385	40	5981
12	5885	14	10970	10	13450	5	15440	48	7034
19	7825	21	12370	18	13080			65	7900
27	10189								
46	11780								
54	11370								
61	11140								
70	11210								

TABLE III

Sorption of Cs^{134} by humic acid in sea-water

Time (days)	Activity in cpm. per ml. filtrate of	
	Control	Sample
6	1541	1533
13	1453	1480
27	1459	1462
35	1419	1411

Solubilization of Elements by Humic Acid

Fe in Sea-Water.—Fe^{59} (100 λ, 107400 cpm.) was added to each of:

5 ml. DDW	..	Control
5 ml. Sodium humate	..	Sample I, and
5 ml. DCSW	..	Sample II,

each contained in 250 ml. bottle, mixed well and kept for 1 hour with intermittent shaking. To the control bottle was then added 5 ml. DCSW and 90 ml. sea-water, to Sample I bottle was added 5 ml. DCSW and 90 ml. sea-water, and to Sample II bottle was added 90 ml. sea-water and 5 ml. sodium humate.

The pH of the contents in the bottles was found to be 8·1. These were shaken well and kept for 24 hours with intermittent mixing. Aliquots were withdrawn at intervals immediately after thorough mixing, filtered and 1 ml. filtrate counted. Results are shown in Table IV.

TABLE IV

Solubilization of Fe^{59} by humic acid in sea-water

100 λ of Fe^{59}: 107400 cpm (1·8 μg. Fe)

Time (days)	Activity in cpm per ml. filtrate of		
	Control	Sample I	Sample II
1	26	223	35·5
4	20	200	46
9	26	201	59·4
16	23	171	54
39	16·5	113·5	58

Fe Zr-Nb and Ce in water and dilute alkali.—For each isotope, two well-cleaned centrifuge tubes were taken:

Tube 1 ..	Control :	5 ml. DDW,
Tube 2 ..	Sample :	5 ml. sodium humate (12·84 mg.; pH 7·9).

Each tracer (100 λ) was added to the tubes, pH was adjusted to 7 and the tubes were allowed to stand for 24 hours with intermittent shaking. Well-mixed solutions (2 ml.) were filtered and 1 ml. aliquots of the filtrates counted. The pH of the remaining 3·1 ml. solution in the tubes was raised to 10 with strong caustic soda, allowed to stand for 24 hours, 2 ml. of the well-mixed solutions were again filtered and 1 ml. aliquots counted. The balance of 1·1 ml. remaining in the tubes was diluted with 9·9 ml. of pH 10 water (*i.e.*, dilution by a factor of 10), allowed to stand for 24 hours, filtered, and 1 ml. aliquots were counted. Results are shown in Table V,

TABLE V

Solubilization of Fe^{59}, Zr^{95} and Ce^{144} by humic acid in water and dilute alkali

	Fe^{59}	$^*Zr^{95}$-Nb^{95}	$^*Ce^{144}$
Added activity (cpm)	1174 (0·07 μg.)	26349	23619
	Activity in cpm per ml. filtrate of		
	Fe^{59}	Zr^{95}-Nb^{95}	Ce^{144}
Control:			
pH 7 ..	225	4273	12462
pH 10 ..	82	444	4538
pH 10 : dilution 10	8	32	449
Sample (humic acid):			
pH 7 ..	1152	25955	23894
pH 10 ..	1161	26510	23829
pH 10 : dilution 10	112	2506	2395

* Separated from fission products.

Ba, Fe, Y and Zr-Nb in ammonia water.—Experiments were conducted in 2% ammonia and comparison was made with ammoniacal EDTA. Ba^{133} as $BaSO_4$, Fe^{59} and Y^{90} as chlorides and Zr^{95}–Nb^{95} as $ZrO(NO_3)_2$ were used. To 1 ml. each of ammonium humate and ammoniacal EDTA, both equivalent to 1·7 mg. each, were separately added 1 ml. of 20% ammonia, the respective isotopes and the volumes were made upto 10 ml. They were shaken well, kept for 24 hours with intermittent mixing (10 days for Zr^{95}–Nb^{95}), filtered and aliquots (5 ml. for Ba, 1 ml. for others) of the filtrates counted. Aliquots (2 ml. for Ba, 1 ml. for others) of each were separately passed through Dowex 50 W-× 8 (50–100 mesh) cation exchange columns (2 cm. × 1 cm.) conditioned with 2% ammonia water. columns washed with 2% ammonia; effluent (including interstitial volume) and washings collected, evaporated to the volume necessary for the standard geometry (5 ml. for Ba, 1 ml. for others) and counted. Results are shown in Tables VI and VII.

TABLE VI

Solubilization of Ba^{133}, Fe^{59}, Y^{90} and Zr^{95}-Nb^{95} in ammonium humate

	Ba^{133}	Fe^{59}	Y^{90}	$^*Zr^{95}$–Nb^{95}
Added activity (cpm)	4352 (1217 μg.)	24715 (98 μg.)	284200 (170 μg)	18854
	Activity in counts per minute in filtrate of			
	Ba^{133}	Fe^{59}	Y^{90}	Zr^{95}-Nb^{95}
Control ..	Nil	Nil	10444	4468
Ammonium humate	3198	13698	172760	20140

* Separated from fission products,

TABLE VII

Ion exchange behaviour of metal ion complexes with humic acid and EDTA on a Dowex 50 cation column in NH_4^+ form

Sample	Activity in cpm in		% passing through the column
	Influent	Effluent and washings	
Ba^{133}-H.A. ..	639	Nil	..
Ba^{133}-EDTA ..	634	Nil	..
Fe^{59}-H.A. ..	1370	1362	100
Fe^{59}-EDTA ..	1300	1290	100
Y^{90}-H.A. ..	17276	10711	62
Y^{90}-EDTA ..	12174	10800	97
Zr^{95}-Nb^{95}-H.A. ..	2014	1917	95·2
Zr^{95}-Nb^{95}-EDTA ..	1440	948	65·8
Mn^{54}-H.A. ..	203	197	100
Co^{60}-H.A. ..	1944	1774	91·3
Zn^{65}-H.A. ..	4623	639	20·3

Mn, Co and Zn.—Humic acid, which sorbed Mn^{54}, Co^{60} and Zn^{65} in the earlier experiments in sea-water (*see* sorption experiments above), was filtered, washed free of sea-water, dissolved in 5 ml. of 2% ammonia and filtered. 1 ml. of these filtrates were directly counted and 1 ml. aliquots of each were passed through Dowex 50 W-× 8 (50–100 mesh) cation exchange columns in NH_4 form as above; columns washed with 2 ml. of 2% ammonia; effluents (including interstitial volume) and washings were collected, evaporated to 1 ml. and counted. Results are shown in Table VII.

RESULTS

Sorption of Radionuclides by Humic acid in Sea-Water

There was an increase in the sorption of elements by humic acid with time; K_d values became constant after a certain period. For Mn^{54}, saturation value was reached after 46 days with the K_d in the range of 11200 to 11800; Co^{60}, 4·5 hours and K_d of 11400 to 12400; Zn^{65}, a week and K_d of 12300 to 13500; and Y^{90}, 2 days and K_d of 15400 (*see* Table II). Sorption of Cu^{64} increased with time, but the saturation value could not be observed with good counting statistics because of its short half-life. The maximum K_d value obtained in the course of 65 hours was about 8000 (Table II). Cesium was not sorbed by humic acid; this may be attributed to the presence of high concentrations of competing ions (Table III). Szalay and Szilagyi[8] observed the quantitative release of Cs^{137} from a humic acid column in presence of 0·1% NaCl. Ganapathy *et al.*[9] reported a high sorption of Cs^{137} by a marine sediment, however, he did not observe any influence of organic matter in the sorption.

Solubilization of Elements by Humic Acid

Fe in sea-water.—Table IV shows the results obtained on the solubilization of Fe in sea-water in presence of humic acid. The control filtrate shows only 2·5% of the added activity whereas the filtrate from Sample I shows 22·3% of the Fe to be in solution. The ratio of Sample I activity to the control filtrate activity is approximately 7 to 10, whereas the filtrate of Sample II shows about 3·5% in solution on the first day and this progressively increases to about 10 to 11% in the course of 39 days. From the order of addition of the different solutions in the experiment, it is apparent that in Sample I, interaction between iron and sodium humate predominantly takes place in the dissolved phase of the two reactants, and in Sample II, sodium humate interacts with precipitated iron hydroxide. The progressive dissolution of this precipitated iron is quite demonstrative in the results whereas the Sample I results indicate completion of interaction in the very early stages of addition.

Fe, Zr-Nb and Ce in water and dilute alkali.—Solubilization of Fe^{59}, Zr^{95}-Nb^{95} and Ce^{144} by humic acid is well illustrated in Table V. Fe^{59}, Zr^{95}–Nb^{95} and Ce^{144} precipitated in the control tubes to the extent of about 81%, 84% and 47% respectively at pH 7 while at pH 10 precipitation increased to about 93%, 98% and 81% respectively. Further dilution with pH 10 water had no significant effect on their precipitation. At pH 7, Fe^{59}, Zr^{95}–Nb^{95} and Ce^{144} were all retained completely in solution by sodium humate while rise in pH did not effect any precipitation of the elements to any appreciable extent. Further dilution with water at pH 10 by a factor of 10 had no influence on the solubilization of the elements by humic acid.

Ba, Fe, Y and Zr-Nb in ammonia water.—Results are shown in Tables VI and VII. In ammoniacal medium, significantly large quantities of the insoluble barium sulphate, iron, yttrium and zirconium-niobium were solubilized by ammonium humate, the amount of Y^{90} and Zr^{95}–Nb^{95} solubilized being respectively 17 and 4–5 times that obtained in the respective controls.

The column studies indicate that the solubilized Ba, being retained completely on the column, must be present in a cationic complex and/or in exchangeable cationic form. The column behaviour of humic acid complex bears a very close similarity with the column behaviour of $BaSO_4$-EDTA complex.

Column studies with Fe indicate 100% escape of Fe^{59} activity through the column, *i.e.*, Fe-humic acid complex is completely 'non-ionic' or 'anionic'. The behaviour is closely similar to the Fe-EDTA complex.

62% of solubilized yttrium passed through the column indicating a 'non-ionic' or 'anionic' complex state of the Y-humic acid compound. This can be compared with 97% of Y-EDTA complex passing through the column.

This column behaviour of trivalent elements-humic acid complex gives support to the observation of Alexandrova[2] that these are usually present in the anionic part of the humic acid.

It is interesting to compare the 95% of Zr-Nb-humic acid complex with the 66% Zr-Nb-EDTA complex passing through the column. The equivalence and the chemical nature of humic acid complexes not being established, it was not possible to compare, on the basis of results obtained in these experiments, the stability constants in quantitative terms with those of EDTA complexes. In the relative scale, however, one can see that the humic acid complexes of stability equal to, less than and greater than EDTA complexes, are possible.

In separate experiments it was observed that the activities in the dissolved part of Mn^{54}, Co^{60} and Zn^{65} in ammonia are quantitatively retained on the column, but in presence of humic acid, 100% Mn^{54}, 91% Co^{60} and 20% Zn^{65} came down with the effluent.

It is to be noted, in these experiments, that elutions were not carried out with large volumes of the eluant in order to follow the elution characteristics of the constituents retained on the column. Rather, the objectives of the experiments were to obtain the fraction of the solubilized product which passed through the column simultaneously with humic acid.

DISCUSSION

Initial concentrations of the elements at which the sorption experiments were carried out with humic acid in sea-water were in the range of 10^{-6} M to 10^{-8} M ; humic acid concentration was 0·1284 mg./ml. Mn, Co, Zn, Y and Cu were practically completely sorbed. Fe remaining in solution with the dissolved fraction of humic acid in sea-water was observed to be about 3×10^{-8} M. Although the total exchange capacity of added humic acid was far in excess of the equivalents of the trace elements under consideration, the equilibration was observed to be a slow process ranging from days (for Co, Zn, Cu, Y, etc.) to a month (for Mn). The precipitated humic acid when dissolved in ammonia and passed through the cation column in NH_4 form (*see* Table VII), Mn and Co passed through the column quantitatively and Zn partly, indicating that the elements sorbed by humic acid are not necessarily at the ion exchange sites.

Similar observations apply in respect of the column experiment with humic acid solubilized Fe, Y and Zr-Nb in ammoniacal medium. Of the elements studied, only $BaSO_4$, solubilized by humic acid in ammonia medium, is retained on the column quantitatively and it is interesting to note that the equivalents of Ba solubilized by humic acid (383 meq./100 gm. of humic acid) correspond to the ion exchange capacity of the humic acid (383 meq./100 gm. of humic acid) obtained by potentiometric titration. However, these complexes were comparable to EDTA complexes in their, column behaviour.

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LETTERS TO THE EDITOR

EXTENDED POINT GROUPS

THE introduction of the anti-identity operation increases the number of the point groups from 32 to 122. These 122 groups are generally classified into three categories, namely: (*i*) the 32 crystallographic point groups, (*ii*) 32 grey groups containing the anti-identity operation explicitly and (*iii*) 58 double-coloured point groups consisting of one or more of the complementary symmetry operations introduced by Zheludev.[1] The classification of symmetry groups and the groups of various kinds of anti-symmetry has been defined more precisely by Zamorzaev[2] and Galyarskii and Zamorzaev.[3] The connection between coloured symmetry point groups and one-dimensional complex representations of the ordinary crystallographic point groups has been investigated, without the use of the representation theory, by Indenbom, Belov and Neronova.[4] Introducing a new definition of equivalence, which is a generalisation of the concept adopted earlier by Krishnamurty and Gopalakrishnamurty,[5] of two irreducible representations of the same dimension and nature of a crystallographic point group, it is shown, in this note, that the number of the point groups can be extended from 122 to 174.

Two alternating representations of a crystallographic point group G have been regarded[5] as magnetically equivalent, if the associated subgroups of index 2 of G are isomorphous. From the above concept, we observe that the magnetic equivalence of two alternating representations of a point group G arises only in the case of those point groups which have two conjugate classes of equal order consisting of isomorphous (or equivalent) elements.[6] Further we note that by interchanging two such conjugate classes, the characters of the elements of the conjugate classes are also interchanged. If, in the process of interchange of two such classes, an alternating representation A of G goes over into istelf, then A is an inequivalent representation. But if A goes over to B of G and B, in turn, goes over to A, then they are to be regarded as magnetically equivalent. For instance, the alternating representations A_2, B_1 and B_2 of the point group 222 are magnetically equivalent. Generalising these ideas, we are lead to the following definition: two irreducible representations of the same dimension and of the same nature (both real or complex) of a crystallographic point group G are regarded as physically (or magnetically) equivalent, if one goes over into the other by an interchange of two conjugate classes of G, which are of the same order and consist of isomorphous elements.

This definition has been applied to the various irreducible representations of the 32 crystallographic point groups. Consequently, 18 one-dimensional complex representations, 23 two-dimensional real representations and 11 three-dimensional real representations are found to be distinct, in addition to the known 58 alternating representations and the 32 identity representations. The distribution of the 18 distinct one-dimensional complex representations is indicated below against the corresponding point groups:

$$4\,(1);\quad 4\,(1);\quad \frac{4}{m}\,(2);\quad 3\,(1);\quad \bar{3}\,(2);\quad \frac{3}{m}\,(2);$$

$$6\,(2);\quad \frac{6}{m}\,(4);\quad 23\,(1)\text{ and }m\,3\,(2).$$

In the light of this definition, all the 23 real two-dimensional and 11 three-dimensional real representations present in the 32 point groups are found to be distinct. Assuming that each distinct representation induces a new group, as is true in the case of alternating representations, we conclude that 52 new groups can be induced by the 52 distinct representations enlisted above. These 52 groups together with the 122 groups described earlier constitute the 174 extended point groups. The validity of the definition introduced in this note can also be judged from the fact that it leads to known results in the case of one-dimensional complex,[4] alternating[5] and identity representations.

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Andhra University, T. S. G. KRISHNAMURTY.
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E.P.R. STUDIES OF CADMIUM DOPED COPPER SULPHATE PENTAHYDRATE

Paramagnetic resonance absorption of Cu^{2+} ions in copper sulphate pentahydrate has been the subject of extensive investigation.[1-3] In such undiluted crystals, the E.P.R. specturm does not give full details due to the strong dipole-dipole and exchange interactions. The E.P.R. spectrum at 3 cm. wavelength of this crystal gives rise to only a single resonance line due to the strong exchange interaction between the two magnetically dissimilar copper ions in the unit cell. By introducing the Cu^{2+} ions in small number in isomorphous crystals the effect of exchange and dipole-dipole interaction can be removed between the paramagnetic ions. Recently, Kokozka and Allen[4] studied the E.P.R. spectrum of zinc-doped copper acetate monohydrate, containing 1% zinc at 77° K. and found a considerable change from the spectrum of copper acetate. The authors have taken up the study of paramagnetic resonance in cadmium-doped copper sulphate pentahydrate crystals.

A X-band E.P.R. spectrometer, using 100 Kc./s. field modulation with recording arrangement has been set up in this laboratory and has been used in these investigations. Saturated aqueous solutions of copper sulphate pentahydrate and cadmium sulphate are mixed in 1 : 1 proportion and are allowed to crystallize by slow evaporation. This has yielded cadmium-doped copper sulphate pentahydrate crystals having a concentration of about 2·5% for cadmium. The crystals are of a size 6 mm. × 4 mm. × 3 mm. The crystals are found to have the same morphological features as that of copper sulphate pentahydrate. These crystal samples are placed inside a silver-coated perspex cylindrical cavity operating in H_{11} mode tuned to a frequency of 9440 Mc./s. The E.P.R. spectrum of this crystal in 110 plane has been recorded for every 10° change of the direction of the magnetic field. The field direction is effected by rotating the magnet about a vertical axis in the 110 plane of the crystal. With this arrangement it is not possible to take the spectra from 0° to 180° in one setting of the crystal because of the microwave magnetic field distribution in the H_{111} cavity. A splitting of the resonance line of copper ions is observed over a range about 15° change in the direction of the magnetic field, as shown in Fig. 1. Spectra are recorded at closer intervals over this range to depict clearly the variation in intensity of the two lines at different positions. Table I gives the variation of '*g*' values and the half-line width with angle, observed in this plane taking the line of intersection between the 100 and 110 faces as the reference direction.

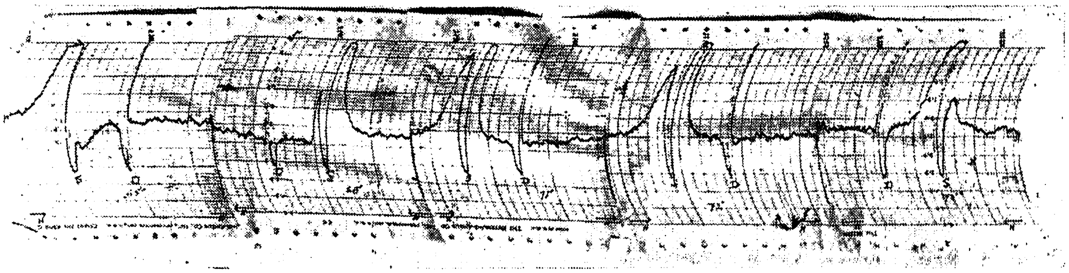

FIG. 1. Splitting of the paramagnetic resonance line in cadmium-doped copper sulphate penta hydrate, at different angles in the 110 plane. Arrows indicate increasing field direction. S—Resonance lines due to Cu^{2+}; D—Resonance lines due to DPPH.

TABLE I

Variation of 'g' values and half-line width with angle in 110 plane

Degrees ..	0	10	20	30	40	50	60	65	70	75	80	90	100	110	120
'*g*' values ..	2·28	2·26	2·21	2·20	2·16	2·15	2·14	2·15 2·13	2·14 2·16	2·15 2·17	2·16	2·19	2·21	2·24	2·21
Half-line widths	95	102	113	70	76	57	70	45 38	25 38	38 44	38	38	64	76	102

The two split lines are found to be of equal intensity at an angle of about 71° with respect to the above reference axis. It can also be seen from Table I that this coincides with an angle where the '*g*' value goes through a minimum. It is, however, necessary to study the spectrum of this crystal in other planes so as to fix the principal magnetic axis of the two copper ion species. The splitting of the line in this crystal can only be due to the formation of copper-cadmium units, in addition to the presence of copper-copper units. Further work on this crystal is in progress.

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Physics Department, B. ANJANEYA SASTRY.
Osmania University, G. SIVARAMA SASTRY.
Hyderabad-7, *August* 27, 1969.

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THE EMISSION SPECTRUM OF NICKEL MONOCHLORIDE

ACCORDING to the recent work of Reddy and Rao[1] and Rao and Rao,[2] the spectrum of NiCl as excited in a heavy current discharge from a D.C. generator is known to consist of brief systems of bands designated as A_1, A_2, A_3, B_1, B_2, C, D, E_1 and E_2 in the visible region λλ 4400–4650 Å and F, G, H, I and J in the photographic infrared region λλ 6350–8750 Å. Some of the band systems from A_1 to E_2 were observed to be single-headed while others were double-headed. Of the five systems observed in the region λλ 6350–8750 Å, the F, G and I systems consist of single-headed bands while H and J systems consist of double-headed bands. The observed structure of the band systems was attributed to transitions of the type $^2\Delta$–$^2\Delta$ or $^2\Delta$–$^2\Pi$ or their case (c) equivalent transitions. However, no attempt has so far been made to know the nature of the transition involved, from a rotational analysis of any of the band systems.

A reinvestigation of the emission spectrum of NiCl has been made using r.f. discharge from a 500 watt oscillator (40 MHz), by photographing the spectra in the first order of a 21 ft. concave grating spectrograph (dispersion 1·25 Å/mm.). Four new systems of bands were observed in the region λλ 4860–5490 Å, which were designated as I, II, III and IV starting from short wavelengths. Each of the systems I, II and III consists of double-headed bands characterised by a strong $\Delta v = 0$ sequence and a weak $\Delta v = -1$ sequence. System IV is a doublet system consisting of single-headed bands. The bands in all tre above systems are degraded to longer wavelengths. The vibrational constants are given in Table I.

TABLE I

Vibrational constants of band systems of NiCl

System	ν (0, 0)	ω_e'	$x_e'\omega_e'$	ω_e''	$x_e''\omega_e''$
I	20534·4 Q	409·6	0·80	431·1	0·20
II	20264·0 Q	382·8	..	423·9	1·35
III	19967·0 Q	403·6	0·05	430·0	0·30
IV	18679·1	412·6	1·60	433·2	1·65

Of the various systems of NiCl, the F and G systems were found suitable for a study of the rotational analysis. The (0, 0) and (1, 0) bands of F system, (0, 0) and (2, 0) bands of G system were photographed in the first order of the 21 ft. concave grating spectrograph. It has been suggested by Rao and Rao[2] that F and G systems belong to a $^2\Delta$–$^2\Delta$ transition by analogy with the corresponding systems of NiH (Heimer[3]). Owing to large multiplet splittings known in the ground and excited states of Ni atom, case (c) equivalent transitions of the type 5/2–5/2 were also suggested both for NiH and NiCl systems.

The rotational structure of each of the bands (0, 0) and (1, 0) of F system, (0, 0) and (2, 0) of the G system reveals the presence of only two branches identified as R and P. Though in

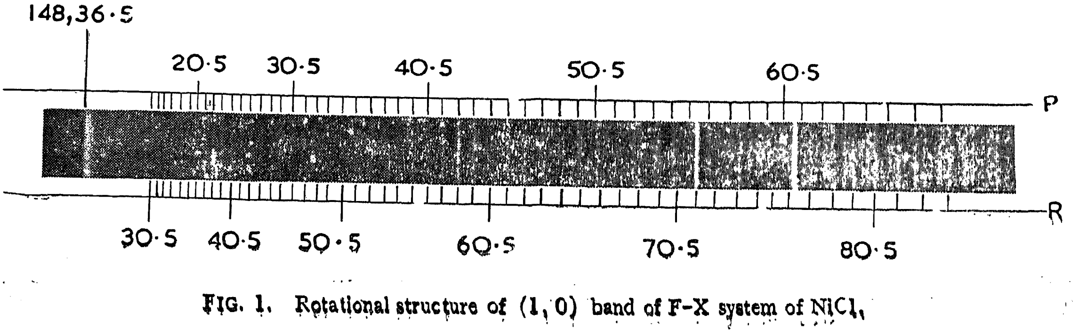

FIG. 1. Rotational structure of (1, 0) band of F-X system of NiCl.

a $^2\Delta$–$^2\Delta$ transition weaker Q branches are expected, they are not observed for want of sufficient resolution near the head. The rotational structure of (1, 0) band of the F system is shown in Fig. 1. A detailed rotational analysis of all the bands indicated that F and G systems have a common lower state. The rotational constants for the upper and lower states, which have been determined from the analysis, are summarised in Table II. It appears likely that the F and G systems belong to transition of the type $^2\Delta_{5/2}$–$^2\Delta_{5/2}$, with a common lower state as in the A and B systems of NiH.

TABLE II

Rotational constants of upper and lower states of F and G systems of NiCl

State	B_e cm.$^{-1}$	α_e cm.$^{-1}$	$D_e \times 10^7$ cm.$^{-1}$	r_e Å	$I_e \times 10^{-40}$ gm cm.^{2}
F	$0\cdot145_4$	$-0\cdot0037$	1·0†	2·290	192·46
G	$0\cdot153_9$	0·0018	..	2·226	181·83
X*	$0\cdot167_0$	..	2·0†	2·137	167·56

* The ground state constants are for the $v'' = 0$ level.
† Variation of D_v with v is neglected.

Spectroscopy Lab., N. V. KRISHNA RAO.
Department of Physics, P. TIRUVENGANNA RAO.
Andhra University,
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EFFECT OF VISCOSITY ON THE DIELECTRIC RELAXATION TIME OF TERT-BUTYL AMINE

THE dielectric relaxation time of tert-butyl amine has been determined by Krishnaji and Mansingh.[1] It is a nearly spherical molecule and the above study shows that the molecule conforms to Debye[2] behaviour, where the dielectric relaxation time has been related to the static viscosity η_s of the medium surrounding the rotating dipole. It is with a view to verify if the Debye relation is valid for a nearly spherical molecule that the present study has been made. This communication reports the dielectric data of tert-butyl amine in five solvents, of varying viscosity, obtained by using benzene and Nujol mixtures.

The permittivity and dielectric loss for this molecule have been determined at a microwave frequency of 9·8 GHz and at 30° C., using standard shorted wave technique. The relaxation time τ and the dipole moment μ have been evaluated by Gopal Krishna[3] method. The values of ϵ', ϵ'', X and Y are shown in Table I and τ and μ are given in Table II.

TABLE I

Permittivity and dielectric loss of tert-butyl amine in solutions

$\lambda = 3\cdot1$ cm. Temperature 30° C.

Concentration in moles per c.c. $\times 10^4$	ϵ'	ϵ''	X	Y
Solvent—Pure benzene, Average viscosity = 0·598 cp				
2·881	2·315	0·018	0·3055	0·0028
3·799	2·320	0·022	0·3067	0·0036
4·719	2·342	0·022	0·3102	0·0036
5·639	2·372	0·024	0·3150	0·0037
Solvent—80% benzene + 20% Nujol, Average viscosity = 0·713 cp				
4·801	2·340	0·033	0·3105	0·0053
6·896	2·372	0·037	0·3156	0·0058
8·736	2·402	0·039	0·3205	0·0061
10·640	2·433	0·043	0·3254	0·0066
12·470	2·447	0·049	0·3278	0·0075
Solvent—60% benzene + 40% Nujol, Average viscosity = 0·967 cp				
4·802	2·326	0·020	0·3075	0·0032
6·642	2·355	0·023	0·3122	0·0036
7·592	2·362	0·026	0·3137	0·0040
10·668	2·394	0·032	0·3188	0·0049
12·659	2·424	0·039	0·3238	0·0060
Solvent—40% benzene + 60% Nujol, Average viscosity = 1·530 cp				
4·911	2·293	0·022	0·3023	0·0036
7·494	2·301	0·028	0·3040	0·0046
8·742	2·342	0·031	0·3107	0·0049
10·746	2·359	0·035	0·3136	0·0054
12·702	2·394	0·052	0·3198	0·0082
Solvent—20% benzene + 80% Nujol, Average viscosity = 3·331 cp				
4·586	2·238	0·031	0·2938	0·0052
6·557	2·274	0·037	0·[illegible]001	0·0061
8·446	2·301	0·038	0·3045	0·0062
10·347	2·321	0·042	0·3080	0·0068
12·644	2·359	0·048	0·3143	0·0076

TABLE II

Dielectric relaxation time and dipole moment in different viscosity solvents

Viscosity cp	Relaxation time sec.	Dipole moment Debye
0·598	$1\cdot8 \times 10^{-12}$	1·31
0·713	$2\cdot0 \times 10^{-12}$	1·26
0·967	$2\cdot2 \times 10^{-12}$	1·32
1·530	$2\cdot3 \times 10^{-12}$	1·28
3·331	$2\cdot4 \times 10^{-12}$	1·28

It is found that the rate of increase of relaxation time is very slow as compared to the increase in viscosity. According to the Debye theory the increase of relaxation time should be linearly proportional to the increase of viscosity of the surrounding medium. For tert-butyl amine, which is a nearly spherical molecule, the Debye equation should be valid. However, from the results it is clear that there is hardly any dependence of relaxation time on viscosity, showing a departure from the Debye behaviour. Higasi[4] has suggested an empirical relation

$$\tau = \mathrm{A}\,\eta_s^{\,x}$$

where A is a constant and x is a parameter less than 1. This relation gives an approximate linear relationship between log τ and log η_s at a constant temperature. He has shown that for spherical molecules x is nearly zero indicating that there is little dependence upon viscosity. Debye equation is, therefore, invalid here.

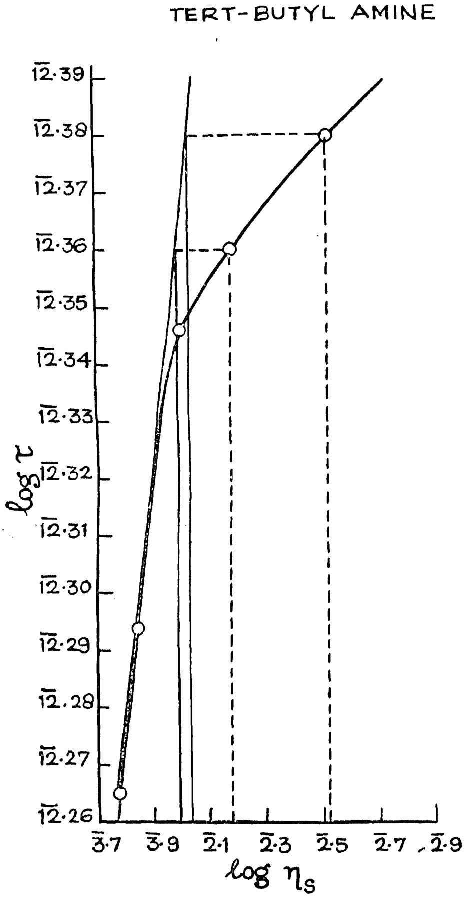

FIG. 1

The author has studied four nearly spherical molecules in very high viscosity solvents,[5] where similar results were obtained. Those results were explained on the basis of the concept of dynamical viscosity. The dynamical viscosity cannot be determined experimentally at very high freqrencies. Hence, a linear extrapolation of the low viscosity data has been done. The visco-elastic relaxation time τ_s has been determined by the expression given by Barlow and Lamb,[6] using the measured values of η_s and the extrapolated value of dynamical viscosity η from the curve (*see* Fig. 1). For 80% Nujol and 60% Nujol the values of τ_s are $0 \cdot 22 \times 10^{-10}$ sec. and $0 \cdot 11 \times 10^{-10}$ sec. respectively, which are of the right order of magnitude. The values of μ, determined in all the five solvents, are within the experimental error, in agreement with the literature value.[7] The value of μ varies only slightly with the solvent.

The author is grateful to Professor Krishnaji for supervision.

Physics Department, DINA NATH.
University of Allahabad,
Allahabad-2, *September* 5, 1969.

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ISOLATION OF KAURENOIC ACID FROM *ENHYDRA FLUCTUANS*

IN an earlier communication,[1] we reported the isolation of a new sesquiterpene lactone named enhydrin from the petroleum ether extract of *Enhydra fluctuans* and proposed a tentative structure for it. Detailed examination of the other fractions of this extract revealed the presence of a diterpene acid which has been studied now.

The petroleum ether extract of *E. fluctuans* after concentration to a low volume deposited a solid which was filtered and repeatedly washed with cold light petroleum followed by the warm solvent. The residue contained mainly enhydrin along with other very minor components. The mother liquor on column chromatography over silica gel yielded in benzene : petroleum ether (80 : 20) eluate, a compound in an almost pure form. It was further purified by repetition of the column chromatography followed by crystallisation. It had an m.p. 180–82°, $[\alpha]_D - 105\cdot4°$ and it analysed for $C_{20}H_{30}O_2$ and had M^+ 302. Its i.r. spectrum (nujol) had the carbonyl frequency at 1695 cm.$^{-1}$ attributable to the presence of a carboxyl group as the compound was also soluble in $NaHCO_3$. Its reaction with CH_2N_2 to form the ester provided further confirmation. This accounted for both the oxygen atoms in the compound.

The presence of unsaturation was shown by i.r. absorptions at 1655 and 875 cm.$^{-1}$. The compound also gave a positive TNM test. A quantitative catalytic hydrogenation agreed with the presence of only one double bond in the compound. Therefore, it was considered to be a tetracyclic diterpene acid.

The n.m.r. spectrum of this acid (δ values) showed two tertiary methyls at 0·98 and 1·27 and a broad signal centered at 4·8 integrating to 2 protons assigned to a terminal methylene group. When the acid was converted into the methyl ester (m.p. 84–86° C., $[\alpha]_D - 106°$), the two tertiary methyls now appeared at 0·84 and 1·18. This methyl ester on LAH reduction gave the corresponding alcohol (m.p. 142–3° C., $[\alpha]_D - 80\cdot5°$) which was converted into its acetate (m.p. 112–13°, $[\alpha]_D - 67°$). The n.m.r. spectrum of this acetate showed an AB quartet centered at 3·95 assigned to a grouping of the $-C-CH_2-O-CO-CH_3$ type with the axial configuration.[2] In addition, a broad signal centered at 4·7 was also shown attributable again to the terminal methylene group. Reduction of the original acid (Pd/C) gave a saturated compound (m.p. 209–12°, $[\alpha]_D - 67°$) which did not answer the TNM test and whose n.m.r. spectrum showed an extra methyl group and the absence of unsaturation.

All the above-mentioned data agree with the structure of (—) kaurenoic acid with the carboxyl group at the 19 position and the double bond in the 16 position. An acid of this constitution was earlier isolated by Henrick and Jefferies[3] from *Ricinocarpus stylosus* (family: Euphorbiaceæ) and the properties reported by them are as follows: (—) kaur-16-en-19-oic acid, m.p. 179–81°, $[\alpha]_D - 110°$; methyl ester, m.p. 88–89°, $[\alpha]_D - 107°$; (—) kaur-16-en-19-ol, m.p. 141–42°, $[\alpha] - 75°$; its acetate, m.p. 117–18°, $[\alpha]_D - 74°$; 16 β (—) kauran-19-oic acid, m.p. 210–14°, $[\alpha]_D - 68°$. These data agree closely with the series of corresponding compounds obtained from *Enhydra fluctuans*. Direct comparison of the sample of acid of Jefferies with our sample using co-TLC, m.m.p. and co-i.r. showed complete identity. This diterpene acid has also been isolated by Shibata *et al.*[4] from the roots of *Aralia cordata* (family: Araliaceæ). The present report is the first on its occurrence in the Compositae.

Our thanks are due to Professor Jefferies for the kind supply of an authentic sample.

Dept. of Chemistry,
University of Delhi,
Delhi-7,
September 2, 1969.

N. R. KRISHNASWAMI.*
T. R. SESHADRI.
T. N. C. VEDANTHAM.

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* Present address: Department of Chemistry, Central College, Bangalore-1.

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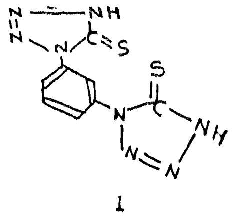
GRAVIMETRIC DETERMINATION OF COPPER, SILVER AND CADMIUM WITH *m*-PHENYLENE-DI-(1-TETRAZOLINE-5-THIONE) (MDT-5)

m-PHENYLENE-DI-(1-tetrazoline-5-thione) (MDT 5) (I), PDT-5, and some other 1-substituted tetrazoline-5-thiones have recently been used in the detection and determination of certain metals.[1-3] The purpose of the present communication is to investigate further uses of MDT-5 for analytical problems. Studies have indicated that MDT-5 reacts quantitatively with Cu^{2+}, Ag^+ and Cd^{2+} ions, at pH range of 5·5–7·0, giving precipitates of insoluble metal complexes. The silver and cadmium complexes are white, whereas that of copper is dark green. The results of elemental analysis show that the mole ratio of 'metal to ligand' is 2 : 1 in the silver complex, and 1 : 1 in copper and cadmium complexes. A method is also described for the determination of cadmium in presence of copper.



I

All the reagents used were of AnalaR grade. The ligand MDT-5 was prepared by the reaction of sodium azide[4] on *m*-phenylene diisothiocyanate.[5] The following stock solutions were prepared:

(A) MDT-5 .... 0·5 g. in 100 ml. of warm acetone.

(B) $CuSO_4.5H_2O$ .... 2 g./l. (standardization of the solution by the usual methods[6] showed that it contained 0·5 mg. Cu^{2+} ion/ml.).

(C) $AgNO_3$ (dried at 120°) .... 1·6 g./l. (this solution was found to contain 1 mg. Ag^+ ions/ml.).

(D) $Cd(NO_3)_2.4H_2O$ .... 2·8 g./l. (this solution was found to contain 1·001 mg. Cd^{2+} ions/ml.).

Determination of Copper.—A known volume (1 to 25 ml.) of B was taken and diluted to about 50 ml. (the amount of Cu did not exceed 30 mg.). The solution was acidified with a few drops of conc. HCl or H_2SO_4, and a freshly filtered A was added. A greenish precipitate of copper complex that formed, was made to flocculate by digesting on the water-bath for 5 minutes, and filtered through a medium porosity sintered glass crucible. It was washed first with 100 ml. of water, then with 25 ml. of acetone, dried at 110–120° to a constant weight (~ 45 minutes), and finally weighed as $Cu(C_8H_4N_8S_2)$. The gravimetric factor for copper is 0·18701.

Determination of Silver.—The procedure was the same as reported previously[1] for a similar determination with PDT-5. The precipitate was dried in a vacuum desiccator, and weighed as $Ag_2(C_8H_4N_8S_2)$. The gravimetric factor is 0·4386.

Determination of Cadmium.—The procedure was the same as described above for copper. The precipitate was dried at 110–150°, and weighed as $Cd(C_8H_4N_8S_2)$. The gravimetric factor for cadmium is 0·2892.

Concentrated solutions metal ions (containing 5–50 mg. Cu^{2+}, Ag^+, or Cd^{2+} ions/ml.) were also prepared and analysed. A summary of combined results of Cu, Ag and Cd determination are given in Table I.

TABLE I

Determination of copper, silver and cadmium with MDT-5

Metal ion analysed	Mg. metal taken		Mg. metal recovered		Error %	
Copper ..	0·50	25·00	$0{\cdot}50_1$	$24{\cdot}91_0$	0·2	0·3
Silver ...	1·00	50·00	$1{\cdot}00_0$	$49{\cdot}89_1$	...	0·2
Cadmium	1·00	25·00	$1{\cdot}00_3$	$24{\cdot}89_8$	0·3	0·4

Determination of Cadmium in Presence of Copper.—The mixed copper-cadmium solution (containing 5–20–folds of Cu^{2+} ions) was treated at PH ≃ 7 with a requisite amount of a 5% aq. solution of EDTA. The solution was stirred and allowed to stand for 5–10 minutes. Only copper was masked by EDTA at this pH. A freshly filtered solution A was then added, when a white precipitate of cadmium complex was formed. The precipitate was further treated as described above.

Coprecipitation studies were also made with Cr and Mn, since these metals are often found present in cadmium alloys and certain corrosion-resistant coatings along with cadmium. The results indicated negligible or practically nil coprecipitation.

The analytical data in Table I, and results of coprecipitation studies indicate that the ligand MDT-5 can act, like PDT-5, as a promising analytical reagent to give new weighing forms for copper, silver and cadmium. The amount of metal down to 0·5 mg., and a maximum of 50 mg. may be determined rapidly. Solutions containing > 50 mg. of metal ions are difficultly determined since the precipitates of these metals with MDT-5 are very voluminous and a little slimy, thus becoming hard to filter. Out of 50 cations tested,[2] only Pb, Hg, Pd, Au, Tl, Ru, Ir, Bi and Pt interfered. With the exception of CN^-, no other common anion caused any interference. The precision of all the determinations was fair, and accuracy within the permissible limits. The high insolubility in water and organic solvents of the precipitates gave an appreciable increase in the sensitivity. A single determination with MDT-5 took ≯ 90 minutes; the error was generally 0·5%.

Dept. of Chemistry, G. S. JOHAR.
V.S.S.D. College, Kanpur,
and
Dept. of Chemistry, UMESH AGARWALA.
Indian Institute of
Technology,
Kanpur, *September* 26, 1969.

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A PRELIMINARY NOTE ON TRACE FOSSILS FROM THE BAGH BEDS OF NARBADA VALLEY

PRESENT communication is intended to notify the occurrence of a variety of Trace Fossils (trails, tracks and burrows) in the Bagh Beds of the Narbada Valley. Most of the material reported here comes from the sandy shales in the upper horizons of the Nimar Sandstone, only a few *species* being from the Nodular Limestone. From the study of only a part of our collection of these fossils we have carried out so far, we have been able to identify the following *species*:

> *Arthropodichnus indicus* gen. *et* sp. nov., *Diplopodomorpha* cretacea gen *et* sp. nov., *Dreginozoum orientale* sp. nov., *Nereites malwœnsis* sp. nov., *Oniscoidichnus communis* sp. nov., *O. ampla* sp. nov., *O. elegans* sp. nov., *O. robustus* sp. nov., *Permichnium bosei* sp. nov., *Tephrhelminthopsis subauricularis* sp. nov., *Tasmanadia sp. indet.*, *Asterosoma spatulata* sp. nov., *Biformites cf. insolitus* Linck, *Fucusopsis cf. angulatus* Vassoievitch, *Lœvicyclus mongrœnsis* Verma[3] *Phycodes gregarius* sp. nov., *Spongeliomorpha cf. iberica* De Saporta, and *Syringomorpha sp. indet.*

Trace Fossils are generally considered poor evidence for age consideration, and hence have been much neglected. But it is of interest to note that among those that we have identified, are *Dreginozoum orientale* sp. nov., *Asterosoma spatulata* sp. nov., and *Fucusopsis cf. angulatus* Vassoievitch which have close resemblance to forms from Upper Cretaceous of U.S.S.R. and Germany; also, while *Tephrhelminthopsis*, a Tertiary *genus* is found by us to extend down into these mid-Cretaceous rocks, several other *genera* known to be confined to older periods are now found to range upwards into the Cretaceous.[1]

The only arthropods known till now to occur in the Bagh Beds, and of which we have any detailed information, are some ostracods described by Jain.[2] But the several arthropod tracks which we have now found occurring in these strata make an important addition to the arthropodous fauna of the Bagh Beds and would provide us additional material for studying the faunal affinities of these rock-formations with those in other basins of sedimentation.

Among the fossils reported here *Arthropodichnus* and *Diplopodomorpha* are myriapod, and being terrestrial air-breathing forms, have important bearing on the conditions under which the Nimar Sandstone was deposited.

In view of what has been reported above there is evidently a need for making a more rigorous search for such fossils from these rock formations, and their detailed study should prove fruitful.

A fuller account of these fossils will appear elsewhere.

Maharashtra Association G. W. CHIPLONKAR.
for the Cultivation of Sci., R. M. BADWE,
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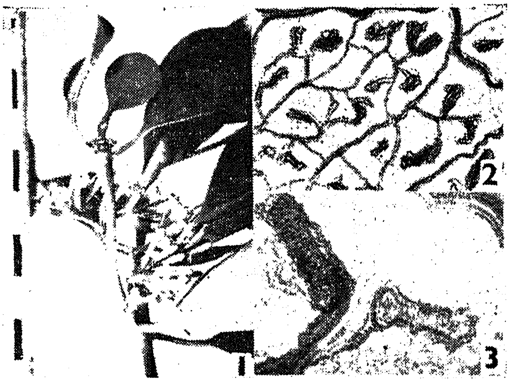
A NEW RECORD OF FOLIAR SCLEREIDS IN *SCYPHIPHORA HYDROPHYLLACEA*

WHILE studying the sclereids in certain mangrove plants of Singapore, palosclereids were observed in the leaves of *S. hydrophyllacea* Gaertn., a member of Rubiaceæ. *Scyphiphora* consists of one species, Indo-Malayan in distribution. Foliar sclereids are reported in only three genera of this family so far, namely, *Burchellia*, *Chomelia*, and *Coffea*.[1-3] The cellular characters and distribution of the sclereids in *S. hydrophyllacea* are briefly discussed here. Foster's[4] methods were followed to obtain the leaf clearings, sections and macerations.

S. hydrophyllacea is a common coastal tree of Singapore and Malaysia, growing to a height of 40–50 feet.[5] The evergreen tree can be easily identified by the presence of reddish or brownish twigs, and fleshy, obovate leaves (Fig. 1). The terminal and axillary buds glisten due to the surface deposition of resin. On an average the leaf measures 57 mm. long, 38 mm. wide at the broadest point, with an area of 1,524 sq. mm. An examination of cleared mature leaves reveals the distribution and association of sclereids with terminal veinlets. Studying their relationship with ultimate veinlets indicates that 98% and 2% of them are terminal and diffuse in their distribution respectively (Fig. 2). It is common that 2–3 sclereids overlap on each other at the distal or sub-distal portions of these veinlets (Fig. 3).

The leaf is a dorsiventral structure, 385 μ thick as seen in transections with 2–3 hypodermal layers arranged next to the upper epidermis. Palisade mesophyll is also 2–3-layered. The spongy mesophyll is 9–10-layered loosely arranged, with many air spaces characteristic of this tissue in other mesophytes.



FIGS. 1–3. Fig. 1. Portion of a twig showing leaf arrangement (cm. scale). Fig. 2. A portion of cleared lamina showing terminal distribution of sclereids, × 9·5. Fig. 3. Enlarged picture showing vein endings, overlapping sclereids (left) and pits on sclereid wall (right), × 420.

In distribution, the sclereids are generally confined to the upper layers of spongy parenchyma, mostly associated with the vascular bundles or present very close to them. Ontogenetic studies are necessary to trace the origin and development of sclereids from the young mesophyll cells. The individual sclereid cell on an average measures 129 × 41 μ, with a thick (5·1 μ), pitted cell wall, and a wide central lumen. Both in leaf clearings and transections, the sclereid cell shows a somewhat irregular rectangular outline with small projections here and there, and the shape of the sclereid cell is not very variable. Recently, De Roon[6] has reclassified the sclereids and distinguished the palosclereids and rhizosclereids using such characters like cell shape, ramifications of the cell, cell wall thickness, lamellation, etc. The sclereids of *S. hydrophyllacea* belong to the category palosclereids. The number of sclereids in a microscopic field (68/area $= 1 \cdot 62\ \text{mm.}^2$) is determined; and if the total number of sclereids per leaf is calculated on this basis, it would be approximately 63,650. In the narrow sub-marginal area the sclereids are absent, and in the rest of the laminar region the sclereids are uniformly distributed. The transverse sections of the stem are also examined and only brachysclereids are present in the pith region, either singly or in small groups of 2–3.

Apart from the genetical characteristics, the resultant shape and to a certain extent the structure of an individual foliar sclereid cell is largely controlled by the compactness of surrounding mesophyll cells amidst which it develops. Other details and exceptions to this general trend of development are discussed by earlier authors.[6,7] The palosclereids are simple structures, small in size, when compared with the other categories of sclereids reported in different taxa.[8–10] Further, these are distinguishable from rhizosclereids in that they have no root-like projections.[6] Studies concerning morphogenesis of sclereids in this species are in progress.

Botany Department, A. N. RAO.
University of Singapore, L. C. WAN
Singapore-10, *July* 29, 1969.

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KARYOTYPE STUDY OF *COLOCASIA ANTIQUORUM* SCHOTT.

Colocasia antiquorum belongs to the family Araceæ and tribe Colocasioideæ. It grows wildly in marshy areas and is non-edible. A karyotype study in this species is reported here.

For karyotype study, pretreatment of root tips with 0·25% colchicine solution for five hours yielded adequately condensed and well-spread metaphase figures.

The chromosome counts and the karyotype analysis were made from metaphase stages. In all metaphase stages the chromosomes were found to be 22 in number ($2n = 22$) (Fig. 1, A). Out of the 11 pairs ($n = 11$), 5 pairs were metacentrics and 6 pairs were submetacentrics (Fig. 1, B). Acrocentric chromosomes were totally absent in all cells. The chromosomes were comparatively small in size and did not show much difference in morphology, size and shape among different pairs.

Karyotype study of this species brings out some features of cytological interest. The karyotype showed V-shaped and J-shaped condition with almost identical morphology among the pairs. If Robertson's view is taken into consideration, the species can be considered as more specialised, because of the presence of only metacentric and submetacentric chromosomes.[1] The present condition might have been achieved by centric fusion.

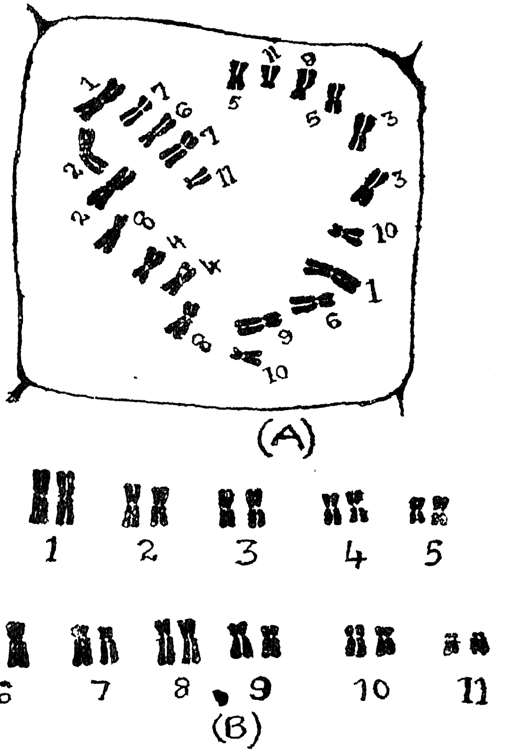

FIG. 1, A-B A. *C. antiquorum* root tip cell showing metaphase chromosomes. B. Karyotype arranged in 11 pairs. (All, × 900).

But the karyotype study of different species and genera of the same family by many authors, especially by Levitzky,[2] showed that plants with symmetrical karyotype having only V-shaped and J-shaped chromosomes are less specialised or generalised species or genus. The specialised species or genus with asymmetrical karyotype and more acrocentric chromosomes evolve from generalised karyotype with symmetrical condition. In this respect this species can be considered as less specialised or generalised, since, it is having only V-shaped and J-shaped chromosomes with symmetrical karyotype.

Thus taking into consideration the external morphological characters like the perennial habit, shallow rooting rhizome, naked flowers, etc. (these characters are primitive according to Stebbins[3]) and karyotype study, it may be concluded that Levitzky's view can be justified and the species can be treated as a generalised species.

Dept. of Botany, R. V. R. Pillay.
D.M. College, Imphal,
September 13, 1968.

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BACTERIAL LEAF-SPOT DISEASE OF *CORCHORUS FASCICULARIS* CAUSED BY *XANTHOMONAS NAKATAE* Var. *FASCICULARIS*

Corchorus fascicularis L., of the family Tilliaceæ, grows during rainy season. A bacterial leaf-spot disease was noticed on this plant at Machhad near Navsari, Gujarat State during September-February, 1967-68. The disease can be recognized easily, since by sectioning the infected portion, the bacterial ooze from the lesion becomes quite conspicuous. The morphological, cultural and physiological characteristics of the pathogen fix its position in the genus *Xanthomonas*. So far three *Xanthomonas* infecting the plants of the genus *Corchorus* have been reported, *viz.*, *X. nakatæ* (Okabe) Dowson for *C. capsularis* L., from Jawa in 1939, *X. nakatæ* var. *olitorii* Sabet for *C. olitorius* L., from Sudan in 1956 and *X. nakatæ-corchorii* Padhya and Patel for *C. acutangulus* from India in 1963.[1-3]

The disease first appears as water-soaked translucent spots which, in later stages, turn dark brown in colour. The spots are round to irregular, measuring 1–2 mm. in diameter. They are usually hypophyllus. The pathogen seems to enter through stomata.

The disease inciting pathogen was isolated on potato dextrose agar medium; distinct yellow-pigmented colonies developed after 48 hours at 28° C. On artifical inoculation of young and mature leaves of *C. fascicularis*, the typical symptoms developed in about 15 days. The pathogen on reisolation was found to be identical with the original.

On artificial inoculation, the pathogen under study could not infect *C. capsularis* L., *C. olitorius* L., *C. acutangulus* L., *Aegle marmelos* C., *Cajanus cajan* M., *Carissa carandas* L., *Citrus aurantifolia* S., *Gossypium arboreum* L., *Phaseolus vulgaris* L., *Ricinus communis* L., *Sorghum vulgare* P., and *Vigna* *catjang* W., from which the *Xanthomonas* diseases are reported. Cross-inoculations were also carried out on *C. fascicularis* with *X. nakatœ-corchorii* and *X. nakatœ* var. *olitorii*. This host was found to be immune, to these pathogens. *X. nakatœ* could not be tried since no authentic culture could be had from any of the well-known culture collections.

So far no bacterial disease is reported for the host *C. fascicularis* and the pathogen isolated differs from *X. nakatœ*, *X. nakatœ* var. *olitorii* and *X. nakatœ-corchorii* in its host range and certain other biochemical reactions. It is therefore proposed to assign a new name *Xanthomonas nakatœ* var. *fascicularis* to this pathogen whose technical description is as follows :

Xanthomonas nakatœ VAR. *fascicularis*
PATEL AND KOTASTHANE

Short rods with rounded ends, usually single, occasionally in pairs, measuring 1·1–1·8 × 0·5–0·8 μ gram-negative, motile by a polar flagellum, encapsulated, no endospore and non acid-fast. Colonies on potato dextrose agar plates are big circular with smooth surface and entire margin, butyrous and glistening yellow. Growth on potato dextrose agar slants is abundant, filiform, convex, smooth, opaque, butyrous and glistening yellow. On nutrient agar slants, growth is moderate, filiform, flat, smooth, opaque butyrous and lemon yellow.

Starch hydrolysed, casein digested, tributyrin hydrolysed, gelatin liquefied and hydrolysed, milk peptonised and litmus reduced, indol not produced, ammonia and hydrogen sulphide produced from peptone, nitrates not reduced to nitrites, V.P. and M.R. tests negative, citrates utilised but not uric acid, tolerates 3% sodium chloride but not 5%. Acid without gas from glucose, lactose, maltose, sucrose, arabinose, fructose, galactose, cellobiose (slight) and raffinose but no acid and no gas from mannitol, xylose, mannose, glycogen, rhamnose, salicin, sorbitol, dulcitol, inocitol, inulin, glycerol, esculin and sorbos. Catalase positive, ærobic, optimum temperature 27° C. to 30° C., thermal death point 54° C.

Pathogenic only to *C. fascicularis* producing spots on leaves.

We gratefully acknowledge the valuable help of Dr. M. V. Desai, College of Agriculture, Anand, Gujarat,

Microbiology Dept.,
B.P. Baria Science Inst.,
Navsari, Gujarat, India,
August 15, 1969.

A. M. PATEL.
W. V. KOTASTHANE.

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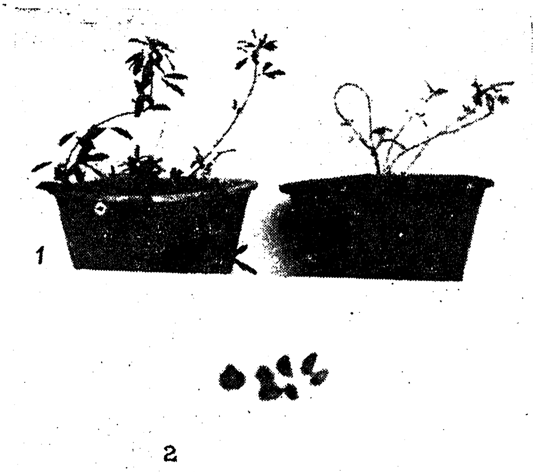
CHROMOSOME BREAKAGE BY COLCHICINE IN *TRIGONELLA FOENUM-GRAECUM* L.

AUTOTETRAPLOIDS of *Trigonella fœnum-græcum* L. were produced by colchicine[9] and amongst the colchicined plants which remained diploid, there was a plant conspicuously short-sized with small leaves (Fig. 1). Floral buds were fixed in acetic-alcohol (1 : 3) and squashed in 1% acetocarmine. 12% of the PMCs studied, showed a quadrivalent at metaphase I (Fig. 2). 65 cells examined at anaphase I showed normal distribution. Pollen fertility, on the basis of stainability with IKI, was lower to controls by 5%.



FIGS. 1-2. Fig 1. Plants of *T. cænum-græcum*. Control (left) and the colchicined diploid (right). Fig. 2. Metaphase I showing $1_{IV} \pm 6_{II}$, × 1,350.

Colchicine, besides being a polyploidising agent has been known to induce chromosome breakage[1-3,6-8] and mutations.[4,5,10] Since this plant, like the pure diploid *T. fœnum-græcum*, has $2n = 16$, it cannot be tetrasomic for one chromosome and nullisomic for another to form a quadrivalent. Presence of a quadrivalent, therefore, is a case of translocation.

The diminutive effect of translocation on the morphological characters may be due to "position effect". Distribution of adjacent chromosomes of the quadrivalent ring to the two poles at anaphase I is expected to make some gametes non-functional. Occurrence of a quadrivalent only in 12% PMCs is suggestive of unequal segments or very small segments involved in translocation so that chiasmata in the translocated segments slip off soon in most of the quadrivalents.

Department of Botany, AVTAR SINGH.
Patna University, R. P. ROY.
Patna-15, *August* 16, 1969.

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APPEARANCE OF *SPHACELOTHECA SORGHI* (LINK) CLINT. IN *SORGHUM* GERM PLASM AT REGIONAL STATION, COIMBATORE

Sphacelotheca sorghi covered smut of *Sorghum* is externally seed borne and can be controlled by seed treatment. There is no evidence of its being transmitted through soil. At the Regional Research Station, Coimbatore, over 4,000 *Sorghum* types collected from all over the world were grown from 1963 to 1966. About 1,000 varieties and selections from crosses are being maintained thereafter. All these years seeds have not been treated with fungicides, yet the crops were free from smuts. This year, however, derivative of a cross between I.S. 84 × Improved Ramkel in F 5 generation showed infection. Sudden appearance of the disease in the germ plasm material which has been free for over five years assumes importance and requires investigations. Observations on smut sori and chlamydospore germination are reported here.

The smut sori as seen in Fig. 1 are localised at the bottom. Individual sori are cylindrical or somewhat conical in shape; measuring 4–7 mm. The soral membrane (peridium) is brown, not easily rupturing. Chlamydospores are round or oval, olive-brown, smooth-walled, diameter 5–6·25 μ. Chlamydospores from matured sori germinated easily in 2% sugar solution at 28–30° C., giving 100% germination. In many cases two types of germination as reported by Butler[1] were observed. Other variations in germination as reported by Tyler[2] have also been observed.

Smut sori observed in other fields are dirty grey in colour and not brown. This may be due to differences in physiologic races, hence studies on the comparative morphology of smut sori and chlamydospores have been taken up.

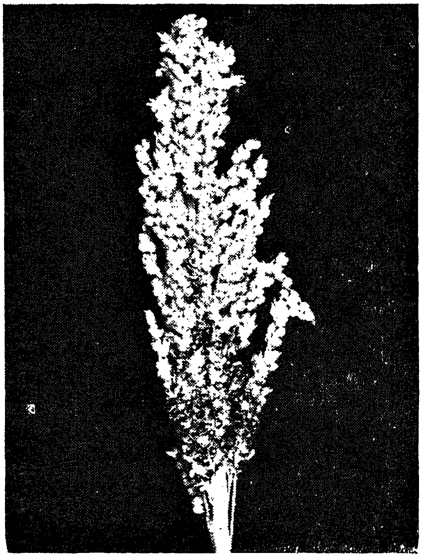

FIG. 1

I wish to record my grateful thanks to Dr. V. Santhanam, Project Co-ordinator (Cotton Research), for providing facilities and encouragement and to Dr. R. V. Vidyabhushanam, Millet Breeder. for supplying the infected material and previous information on *Sorghum* germ plasm.

I.A.R.I. Regional M. R. SIDDIQUI.
Research Station,
Coimbatore, *August* 16, 1969.

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* Original not seen.

REVIEWS AND NOTICES OF BOOKS

Bond to Carbon (Vol. I) (*Group IV: Organometallic Chemistry Series*—Part I). Edited by Alan G. MacDiarmid (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016, U.S.A.), 1968. Pp. xv + 603. Price $ 36.50.

Volume I (in two parts) of the series is entitled, *The Bond to Carbon*. Chapter 1 of Part I presents an overall coverage of the physical basis of the chemistry of the Group IV elements, giving the reader a general bird's eye-view of many factors which are important in shaping the chemistry or structure of these elements and their compounds. Electron configuration, bond lengths, angles, and energies, and the role of *pi* bonding and *d* orbital effects in determining certain physical or chemical properties of compounds are among the aspects examined. Chapter 2 includes a full discussion of the synthesis and reactions of the silicon-carbon bond. Part II covers in considerable detail the synthesis and properties of the germanium-carbon, the tin-carbon, and the lead-carbon bond.

Volume 2 of the series will be concerned with the Group IV element-halogen bond and halogenoid bond, and Volume 3 with the group IV element-chalcogenide bond.

Written by noted authorities in the field, each volume is valuable to research chemists and senior students of organometallic, organic, and inorganic chemistry. It will serve as a good reference for libraries. C. V. R.

Nonequilibrium Flows (Part I). Edited by Peter P. Wegener. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1969. Pp. xii + 254. Price $ 13.75.

The aim of this series is to treat the fundamentals of gas dynamics as well as the advances of recent years. The topic of gas dynamics is interpreted to include any aspect of the dynamics of real gases, the underlying theme being the effects of compressibility. The articles in a single volume will cover only one major subject, the intention being to show some of the many sides of that subject to students and to those already working primarily in a narrower speciality.

Nonequilibrium Flows, Part I, contains discussions of linearized flows and flows with shock waves and also more specialized subjects involving flows of two phases. Future volumes will include experimental methods and topics such as phenomena in the atmosphere and certain aspects of detonations and combustion. This book can be used as a text-book by graduate students in advanced fluid mechanics courses. It is also valuable to aerospace engineers, scientists in the chemical processing industry, and researchers in physics, chemical physics, and engineering. C. V. R.

Encyclopedia of Library and Information Science (Vol. 2). Edited by Allen Kent and Harold Lancour. (Marcel Dekker, Inc., 95, Madison Avenue, New York, U.S.A.), 1969. Pp. x + 707. Price $ 45 per volume (Non-subscription); $ 35 per volume (Subscription).

Volume 2 of this well-known series contains the following articles: Association of American Library Schools; Association of American Medical Book Publishers; Association of American University Presses; Association of British Library Schools; Association Canadienne Des Bibliothecaires; Association for Computing Machinery; Association of Research Libraries; Association Trails; Atlanta University School of Library Service; Auctions; Audiovisual Materials and Services; Libraries in Australia; The Library Association of Australia; National Library of Australia; National Library of Austria; Author Catalog; Authority Files; Authors and Libraries; Automatic Analysis; Automatic Data Processing, Library and Information Center Applications; Awards and Prizes in Library and Information Science; Bank Libraries; Libraries in Barbados; Barrow, William James; Basic English; Batch Processing; Batten System; Beilstein's Handbuch; Libraries in Belgium; Bembo, Pietro; Berenson Library (Biblioteca Berenson); Libraries in Bermuda; Beta Phi Mu; Bible (Manuscripts); Bible (Printed Editions); Bibliographic Classification; Bibliographic Service Center; Bibliographic Systems Center; Case Western Reserve University; Bibliographical Society of America; The Bibliographical Society (London); Bibliography; Bibliography of Agriculture; Bibliomania; Bibliopsychology; Bibliotheque Nationale De France; Bibliotherapy; Bihar Library Association; Library Bill of Rights; Binary Numbers; Binational Center

Libraries; Binder's Title; Binding; Library Binding Institute; Binding Procedures and Programs in Libraries; Biological Literature; Biological Sciences Division of Special Libraries Association; Biomedical Libraries; Biosciences Information Service; Blind and Physically Handicapped; Block Printing; Bodleian Library; Book Catalogs; Book Coupon Scheme, Unesco; Book Exhibits; Book Fairs; and Book Trade;

The Encyclopedia is of value to librarians, information scientists, computer scientists, advanced students and researchers in related fields.

C. V. R.

Introductory College Mathematics with Business Applications. By K. C. Skeen, C. W. Wheeler and R. L. Johnson. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W 1, England), Pp. 456. Price 70 *sh.*

This is an elementary book on arithmetic and simple algebra taught at secondary school level, but adapted to suit the requirements of beginning students in colleges who go in for business courses. There are chapters concerned with applications to business problems such as Family finance, Production and Manufacturing, Marketing and Retail sales, Finance, etc.

A. S. G.

Exercises in Introductory Physics. By R. B. Leighton and R. E. Vogt. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1), Pp. 237. Price 26 *sh.*

These exercises were compiled by the authors for use with Volume I of *The Feynman Lectures in Physics* in the first year introductory physics course at the California Institute of Technology. They are accordingly arranged in the same order as to subject as the Feynman Lectures. Within each topic the exercises are graded as easy, intermediate, and more sophisticated. The last category being more thought-provoking will be of special interest to the better type of students.

This compilation as a companion volume to the original text of Feynman Lectures will be widely welcomed by students of physics as a self-study work-book.

A. S. G.

ANNOUNCEMENTS

Symposium on Taxonomy and Biology of Blue-Green Algae

The First International Symposium on the "Taxonomy and Biology of Blue-Green Algæ" under the auspices of the Madras University will be held in the Centenary Buildings of the University on January 8 to 13, 1970.

Further information can be had from the Organiser, Prof. T. V. Desikachary, Centre for Advanced Study in Botany, University of Madras, Centenary Buildings, Madras-5.

Watumull Memorial Awards

Nominations are invited for the Watumull Memorial Awards open to citizens of India. Those who have contributed to the progress and betterment of the country in the fields of Science, Humanities and Social Sciences are eligible.

For nomination forms and other particulars please write to: Dr. J. V. Bhat, 407, Block I, Rajajinagar, Bangalore-10. Last date for receipt of the completed nomination forms is December 31, 1969.

Award of Research Degree

Osmania University has awarded the Ph.D. degree in Botany to Shri Dhrubash Karan; Sri Venkateswara University has awarded the Ph.D. degree in Botany to Shri M. Prasada Rao.

Books Received

Structure and Mechanism in Vinyl Polymerization. Edited by T. Tsuruta and K. F. O'Driscoll. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1969. Pp. xii + 540. Price $ 29.50.

Science in India's Future. (Press Institute of India, Sapru House, Annexe Barakhamba Road, New Delhi; Vikas Publications, 5, Daryaganj, Ansari Road, Delhi-6), 1969. Pp. viii + 118. Price Rs. 15·00.

An Introduction to Fishing Gear Technology. By K. B. Lal. (B. V. Gupta, Metropolitan Book Co. P. Ltd., 1, Netaji Subash Marg, Delhi-6), 1969. Pp. vii + 229. Price Rs. 16·00.

Superconductivity. Edited by R. D. Parks, Vol. I: Pp. xv + 664. Price $ 45.00; Vol. II: Pp. xv + 665–1412. Price $ 45.00. Set of Volumes I and II: $ 75.00.

1639-69. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6,
and Printed by M. S. Narayanamurthy at The Bangalore Press, Bangalore-18.